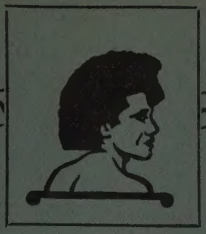
VOL. 19 NOS. 3 & 4. JULY - DECEMBER, 1948.



COLONY OF FIJI

AGRICULTURAL JOURNAL

ISSUED BY THE

DEPARTMENT OF AGRICULTURE, FIJI

PRICE : THREE SHILLINGS.

GOVERNMENT PRESS, SUVA, FIJI

Notes for Libraries and Research Institutes.

FORMER ISSUES OF AGRICULTURAL JOURNAL.

So many requests are received from abroad for parts of the *Agricultural Journal* which were never published that the following list of all issues published and those which are not now available is given for reference. Attention is especially directed to Volume 7 which had only one part:—

Vol.				*Vol.*			
1.	3	numbers,	1928.	10.	4	numbers,	1939 (none of Nos. 2 and 4).
2.	4	„	1929.				
3.	3	„	1930 (none).	11.	4	„	1940 (none).
4.	4	„	1931.	12.	4	„	1941 (none of Nos. 1 and 2).
5.	2	„	1932 (none of No. 2).				
6.	2	„	1933.	13.	4	„	1942.
7.	1	„	1934.	14.	4	„	1943.
8.	4	„	1935–37 (none of No. 4).	15.	4	„	1944.
9.	4	„	1938 (none of Nos. 2, 3 and 4).	16.	4	„	1945.
				17.	4	„	1946 (none of No. 1).

ISSUES OF THE AGRICULTURAL CIRCULAR.

NUMBERS and year of issue of the *Agricultural Circular* :—

Vol. 1,	1920,	12	numbers.	Vol. 4,	1923,	1	number.
2,	1921,	5	„	5,	1924–5,	2	numbers.
3,	1922,	4	„				

As number 4 of Vol. 3 was printed as " Volume 4 " and number 1 of Vol. 4 as " Volume 5 " it would appear from an inspection of a complete set that Volume 4 comprised only a number 4 and that there were two issues of Volume 5, No. 1.

ANNUAL BULLETINS.

THE Annual Bulletin of Divisional Reports ran from 1931 to 1938 and was then discontinued.

OLD ISSUES OF AGRICULTURAL BULLETINS.

FREE copies of the following Bulletins are available to Colonial Departments of Agriculture research institutes and bona fide planters within the Colony.

No. 1. Sisal Hemp in Fiji, 1911.
3. Rhinoceros Beetle in Samoa, 1912.
4. The Banana in Fiji, 1912.
5. Scale Insect on Bananas, 1913.
6. Lemon Grass, 1913.
7. A Mission to Java for a Coleopterous Pest of Bananas, 1914.
8. Coconut Experiments, 1915.
9. Soils of Fiji—I, 1916.
11. Alluvial Soils of Fiji, 1919.
12. Leaf Moth of Coconuts, 1919.
13. Sea Island Cotton, 1920.
14. Transparent Coconut Scale, 1921.
15. Purple Leaf Moth of Coconuts, 1924.
18. Control of Coconut Spike Moth, 1935.

The following are available to the public at the prices shown—

No. 21. Biological Control of the Rhinoceros Beetle, 1941. Price 1s.
21A. Fijian Plant Names, 1942. Price 3s. 6d., 4s. and 6s.
22. An introduction to the Mosquitoes of Fiji, 1943. Price 1s.
23. Insect Pests in Fiji, 1946. Price 1s.
Gardening Notes, Insect Pest Control and Plant Diseases, 1945. Price 1s.

Applications should be made to the Librarian, Department of Agriculture, Suva, Fiji.

—EDITOR.

Agricultural Journal

VOL. 19. JULY - DECEMBER, 1948. NOS. 3 & 4

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DEPARTMENT OF AGRICULTURE.

STAFF LIST

(as at 31st December, 1948).

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	Mrs. M. C. DAVIDSON.
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	D. J. G. DAVIES, Dip. Agric. (N.Z.).
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Meat and Dairy Inspector	R. J. NESBITT.

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Entomologist	B. A. O'CONNOR, B.Sc., Agric. B.A.
Economic Botanist	*Vacant.*
	B. E. V. PARHAM, M.A. (Hons.) (Acting).
Animal Husbandry Officer	*Vacant.*
	H. T. B. HALL B.V.Sc., (Acting).
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	L. E. SMYTHE, M.Sc., A.A.C.I., A.R.I.C.
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	S. PILLAI.
	J. W. PARHAM.

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	R. R. MASON, B.Sc. (Agric. London), N.D.A. Dip. Agric. (Cantab.)
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Assistant Agricultural Officer	S. E. H. COSTER.
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	S. BHARAT. Dip. Agri. (Allahabad).
	L. HARMAN.
	W. GORDON.
Produce Inspector	R. A. D. KABLE, M.B.E.
Librarian and Editor of Agricultural Journal	B. E. V. PARHAM, M.A. (Hons.).

EDITORIAL . . .

THE JOURNAL.

Both an apology and an explanation are due and are made to readers for the late appearance of this issue of the Journal. Shortage of paper and serious congestion of urgent work at the Government Press has combined with circumstances beyond the Editor's control to delay publication; but in order to recover lost time Nos. 3 *and* 4 *of* 1948 *have been brought together in the one issue. A tribute is due to the Government Printer and his staff for the patient handling of the material here brought together to complete Volume* 19.

THE BEEF INDUSTRY.

Since 1942 the amount of beef grown in this Colony has been insufficient to meet the demand. In that year the necessity for supplying a substantial part of the beef required by the New Zealand military forces caused us to make heavy inroads into the reserve of cattle which had accumulated over previous years. This accumulation was a result of the interest of peasants and estate owners in raising cattle and of the comparatively limited market for beef. In pre-war years the price of beef, in comparison with foods of equivalent value, was high and therefore beyond the purse of that section of the community on lower income.

Later in the war years, with so many of the Fijian population being absorbed into the army, in the diet of which meat formed a substantially greater part than would be normal for Fijians at home; and with the loosening up of money consequent upon having a war on our hands, this lower income section of the community was able to acquire a taste for beef, and at the same time have the wherewithal to satisfy that taste. Added to this, the price of equivalent food had risen to a greater extent than had beef which was now within the reach of the purses of a much larger number of consumers.

How, then, were we to cope with this ever increasing demand? Restriction on slaughtering had been effective up to a point; but something more definite to re-establish the industry on a sound footing was needed. The Beef Committee, appointed in April 1948, made a considerable number of recommendations to this end and most of these have been or are being implemented. Many of them were already being considered by Government. For example the tenure of land for cattle raising was being made more secure and placed on better terms; Fijian land reserves were being fixed; efforts were being made to obtain fencing materials and implements; and more effective control of weeds was already in hand. The need for urgency in dealing with all these factors, as well as numerous others, was emphasized by the Committee.

In general, however, it must be accepted that a fully adequate beef supply is contingent upon two factors; the more effective use of our present farm lands to allow for livestock, and the extension of cattle raising in accordance with a well conceived plan.

The more effective use of present farm lands, and the manner in which this may be accomplished has been mentioned often enough in this *Journal* and in reports and statements of this Department not to need further detailed repetition here; but repetition may be allowed in stressing the need for a clearly defined system of alternate husbandry for peasant farmers. The blending of livestock with crops has been the basis of peasant farming practice in many countries for many generations; and where there is a restricted area of arable land, such as in Fiji, where fertility must be maintained if the land is not to deteriorate, the lesson to be learnt from such long established countries should be clear. The value to the beef-eating public of livestock used in such a manner is obvious.

The second factor mentioned, the possible extension of cattle raising to new areas, has recently received attention by the action taken by the Colonial Development Corporation to investigate a large area of land in Ra which would be suitable for cattle raising. Whether the Colonial Development Corporation decides to continue with this proposal or not, the idea is one which could well be kept in mind by those with sufficient enterprise and enough capital to be able to wait some years for returns.

Apart from the Colonial Development Corporation scheme, there is little interest being shown in cattle-raising as a separate, full-time industry at the present time, whereas twenty years ago it formed the only income of a substantial group of farmers. Undoubtedly, weed invasion has accounted in part for this downward trend; but as well as this the increasing population has required more and more land for crop agriculture, land which is placed under crops at the expense of livestock. Such a change over is noticable in many countries, where, as crops encroach on cattle raising, this is moved further and further into marginal areas. In Fiji we are seeing the change over to crops, but instead of moving to the marginal areas, cattle-raising—as an industry—is dying out.

—H.B.T.H.

STAFF NOTES

Mr. B. A. O'Connor, Entomologist, who had left Fiji on the 20th July on a visit to the B.S.I.P., returned on the 20th September and resumed duty on that date. The visit, which was undertaken in co-operation with Mr. Leach of the School of Agriculture Cambridge, had for its object the investigation of the present status of premature nutfall of coconuts. A secondary object was to make general observations, as opportunity offered, on the insect pests of the B.S.I.P.

During August Mr. H. T. B. Hall, then Acting Senior Veterinary Officer, paid a visit to Tonga for the purpose of carrying out a survey of the livestock industries of the Kingdom and of making recommendations for their improvement.

Mr. R. R. Mason was transferred to Lautoka as Agricultural Officer Western with effect from 1st November.

Mrs. Gilmore resigned from her post as Temporary Clerk with effect from 10th September, 1948.

Miss L. Duncan returned from overseas leave and resumed duty on 25th October, 1948.

Mr. R. A. D. Kable returned from overseas leave and resumed duty on 29th October, 1948.

Mr. R. N. Sanders, Animal Husbandry Officer, left Fiji on 22nd June to take up his new appointment as Veterinary Officer in Uganda. Mr. Sanders was first appointed to Fiji on 19th January, 1939, acted as Senior Veterinary Officer during 1946 and was appointed Animal Husbandry Officer as from 1st September, 1946.

Mr. D. A. Donald, H.D.A., left Fiji on 25th October, 1948, on transfer to the Western Pacific High Commission service in the Solomon Islands. Mr. Donald was first appointed Assistant Agricultural Officer in Fiji in 1933 and was promoted to the position of Agricultural Officer in 1938.

Mr. C. R. Turbet, Senior Veterinary Officer, having completed his term of secondment to Ceylon, returned to the Colony on 28th November and resumed duty on the following day.

During November the Deputy Director of Agriculture, Mr. W. J. Blackie paid a visit to Tonga. The main purpose of the visit was to explain to the Tongan Government the Organization of the Central Agricultural Scheme and the services which Tonga could expect from the administrative and technical officers under the Scheme. The visit also afforded an opportunity of studying local conditions with a view to arranging investigations by the technical staff in 1949, and of examining the organisation of the local department for the purpose of making recommendations regarding effective cooperation with the central organization.

AGRICULTURE . . .

THE SIMILARITY OF AGRICULTURAL PROBLEMS IN THE SOUTHWEST PACIFIC: A SUGGESTION.

BY DR. K. B. CUMBERLAND.*

In touring the southwest Pacific island territories, the geographer, interested in the general regional problems of the land and its use, is impressed above all by two features. Firstly, the multiplicity and general similarity of problems that face the planter; secondly, the paucity of trained and experienced agricultural officers available to study and to find remedies for the manifold problems they encounter. Visiting the Fijian, Tongan, Samoan and Cook Island groups one is struck in interviews and casual conversation and in the field by the repetition of similar troubles and difficulties in the different islands.

In all the groups, except Rarotonga in the southern Cook Islands (where coconuts are seriously neglected), the current high price of copra has brought a partial neglect of some other crops, made the maintenance of locally-produced foodstuffs difficult and encouraged increased reliance upon imported canned goods. High copra prices following the disturbance caused by the war have brought a trail of social problems, a shortage of labour, a disinclination to work as hard, more rapid urbanisation of indigenous peoples and a neglect of ancient customs, responsibilities and practices.

In all the groups, except Tonga, ancient systems of land-holding conflict with the demands of the modern commercial age; and the agonies accompanying the transition from the traditional and indigenous to the modern and the introduced are reflected in a host of dependent problems. Unsatisfactory systems of tenure underlie many apparently more pressing problems of the land. Throughout the island groups commercialised forms of agriculture and the contemporary modified forms of indigenous cultivation have brought the signs of decreasing fertility and the threat—in some cases the serious occurrence—of soil erosion. Only in the less densely settled islands of the Tonga group and the low lying atolls of other groups is this not true.

Everywhere weeds are a formidable problem. One is amazed at the extent to which in such a short time man has brought together in isolated island habitats both by accident and design so many aggressive and, for the most part, useless plants from so many different corners of the earth. But it is equally noticeable that of the lengthy list of noxious weeds found today in the island territories of the southwest Pacific the same " shortlist " of serious problem plants occurs in almost all the groups. Occasionally they go under different local names but they are the same species and they present similar problems. The relationship between careless cultivation and exhausted fertility on the one hand and weed invasion on the other is generally appreciated: it is not as frequently noticed that weeds accompany soil erosion, yet there is evidence in many areas that these go closely hand in hand. In this connection it is interesting to notice that on the repeatedly burned ridges of Rarotonga and on the talasiga of Viti Levu the occurrence of the same species—*Gleichenia linearis*—under different conditions of temperature and of rainfall regime indicates advanced sheet erosion and the complete removal of A horizons.

Another outcome of the wasteful disturbance of the indigenous forest cover (especially more recently by firing without reason) and its replacement by second growth and alien weeds is the shortage of timber common to Fiji, Tonga, Rarotonga and Samoa alike. It is an anomalous situation in which once densely forested tropical and subtropical lands are forced to import (at exorbitant prices) shucks for fruit cases and tomato boxes made of timber from North American conifers grown on the formerly treeless volcanic plateau of the North Island of New Zealand. By the time these cases are transported and assembled in the distant islands of the Pacific

* Head of Geography Dept., Auckland University Col.

they sometimes cost the grower more than half what he gets for the produce he exports in them. Only Fiji is not yet dependent on New Zealand for fruit cases, but there are signs that unless something is done to remedy the situation—and done urgently—the time is not far distant when it will be obliged to follow the exemple of Western Samoa, Tonga and the Cook Islands.

In all groups the changing dietary standards of the native peoples, the rising standards of living and the accelerated growth of population have recently pointed to the inadequacy of the livestock-rearing industry and the consequent shortage of meat and other animal products. All are therefore faced similtaneously with similar problems of establishing better pastures and improving herds. In all groups there is need for experimentation with tropical forage grasses and their proper management, need for selection and breeding of better varieties or strains and for continued search for forage legumes suitable for island pastures. This requirement is common and of growing significance and urgency.

Similar problems of internal and external transport, of mass education especially in agricultural and conservational methods and techniques, in commercial practices and marketing arrangements, similar problems of food supply and diet in relation to the health of native groups and of general social organisation occur throughout. In the Cook Islands, Samoa, Tonga and Fiji despite certain variety of physical milieu and despite the variety of administrative organisation and detailed variations in the patterns of indigenous husbandry and of the superimposed commercial agriculture, there is a wide range of land problems that, in a world crying out for tropical produce and foodstuffs, call for co-operative attempts to solve them.

At the moment there is, however, little evidence of co-operation in these matters between the administrative agencies concerned or between individuals working on such problems in the different territories. In each group there are matters that require the attention of specialists in practically every branch of agricultural science— from pedology to entomology and from agronomy to veterinary science. But such specialists cannot obviously be provided in all territories: even if money were found the specialists themselves are not available. As it is, the departments of agriculture are in some groups little more than " one man outfits ". The need for a central corps of experimental specialists is more than obvious. It should be possible, given the desire, to make an arrangement between the different administrations concerned that would make possible the desirable pooling of experience and sharing of responsibility. The South Pacific Commission whose staff is being appointed and whose headquarters is being chosen as this note is written will doubtlessly make the field of agriculture one of its prime concerns; but it seems clear that that body will be concerned with collating research and with making general recommendations on research policy rather than with the actual pursuit of original work. In any case such research as it might ultimately undertake must be of a general, fundamental rather than a local, practical kind. And what is required urgently is the dissemination from group to group of knowledge and experience about the practical solution of a thousand individual problems facing administrators and cultivators alike.

Such knowledge and information is available to the officers of the Department of Agriculture, Fiji, in very much greater abundance than elsewhere in the southwest Pacific. Fiji has much to offer. It is true that this journal helps to disseminate information of great value and it is true that occasions like the meeting of the Seventh Pacific Science Congress in New Zealand next year bring together individuals from different regions, although it is doubtful whether agricultural interests in Rarotonga, Samoa or Tonga will be represented at this particular congress. It is, however, personal contact over a period of time between officers from different territories concerned with either experimental or extension work or both, that enables the results of research and field experience to be transmitted effectively from one island area to another.

What seems necessary under the circumstances is a central corps of specialist advisory or extension officers located in so far as possible in Fiji where alone, in the territories under discussion, experimental work is being conducted. These specialists should be available for service as required for periods of up to six months in any of the different territories co-operating in such a scheme. Whilst at the moment some groups do not have the benefits of the service and training of a pedologist, veterinarian, conservationist, entomologist, or botanist, they could call upon the services of such men from time to time as occasion and problem required. The Director of Agriculture in Rarotonga is a citriculturalist with special experience of tropical conditions in different parts of the world. Although he has not visited adjacent territories, except in passing through, his knowledge and experience could be of immense and much wider benefit. The visit of a pedologist to Tongatapu for a few weeks would provide a reconnaissance soil survey of basic importance in the understanding of a host of problems there. As it is, these soils have not been investigated, but because of their general uniformity they could be studied by a specialist in a very short period of time. Fiji's experience in soil conservation, in taking action against indiscriminate burning, in terrace construction and contour cultivation could be usefully extended to other territories. Tonga could contribute valuable ideas on tenure that would be an improvement on the frequent short leasing and absentee ownership of land in Fiji or the elaborate and involved tribal ownership of the Cook Islands, which makes both transference and use sometimes impossible. Reafforestation with quick growing exotic timbers suitable for fruit cases and with the subsidiary object of conserving soils on overburned hillsides is being discussed. It would be extremely valuable to have brought together the varied experience of different territories and individuals in the rate of growth of introduced species and their suitability for different purposes. Should cacao become an important crop—and with rising prices and declining African output this seems possible—Samoan experience in this field in this region would be invaluable.

Air transport makes it possible today for the individual to get from one group to another more easily than he can visit the different islands of one group. It is also possible in the air age to bring in specialists from outside — from Australia and New Zealand—rapidly and without loss of travelling time. And in the sphere of pasture establishment and management, strain selection and breeding, and livestock rearing the possibility should not be overlooked of the two pacific Dominions participating in the scheme of pooling specialists for co-operative itinerant advisory work in the island territories. Itinerant work of this order would also add to the accumulated experience of the specialist advisors themselves and add point and direction to any experimental work being conducted in the general region.

It is obviously impossible for each island group to have a local agricultural service providing all the specialist abilities and experience its problems demand—impossible even in Fiji. But co-operative effort of the sort described, frequent temporary interchange of personnel, a general extension of facilities for pooling the experience that comes out of local experimentation and advisory work (a *Southwest Pacific Agricultural Journal* would itself be a great help), together with the long-term research planning and co-ordination which will be undertaken by the South Pacific Commission, these together would go far to overcome the technical isolation and the multifarious common agricultural problems that face the southwest Pacific territories at the present time. It is inevitable that these island groups will increasingly contribute to world food and industrial raw material supplies. The sooner this is made possible and the more efficiently it is planned and prepared for the better for a world hungry for both food and tropical raw materials.

FIJIAN PASTORAL DEVELOPMENT.

Fig 1: General view of Wainibuka River Valley, Province of Ra, looking towards the West. King's Road in mid-foreground. Dobuilevu District Farm at lowermost bend of river. Photo: Public Relation Office.

During the Budget debate of Legislative Council in November 1947 the Hon. Joeli Ravai made a suggestion that Government should give consideration to the possibility of a loan from Colonial Development Funds to assist Fijians to develop their land for pastoral purposes. He said—

"Fijians nowdays want to use their own land. The difficulty is how to find money, how to find implements. In that respect I would like to ask Government if it would be possible to allow a loan from the new development scheme to encourage these Fijians to go into dairy farms rearing animals, pigs poultry and also developing their lands . . If Government wishes Fijians to use their land, I apply on their behalf for assistance from Government."

As a result of this proposal, His Excellency the Governor appointed a Committee under the Chairmanship of the Economic Adviser with the following terms of reference:—

"to examine the practicability of a large scale pastoral development of land owned by Fijians and to draw up a plan for consideration by Government covering such questions as the acquisition of suitable land, the size of the capital investment and the source of finance, the management of the scheme, its estimated returns and other allied matters."

The Committee comprised the following:—

Hon. R. M. Taylor (Economic Adviser).
Hon. Ratu Sir Lala Sukuna, K.B.E., (Secretary for Fijian Affairs).
Hon. W. H. B. Buckhurst (Director of Lands, Mines and Surveys).
Hon. H. M. Scott, D.F.C.
Hon. Joeli K. Ravai.
Messrs. W. E. J. Donovan (Accountant-General),
H. King Irving,
B. E. V. Parham (Senior Agricultural Officer) and
J. H. H. Millett.
Mr. G. W. Kiss was invited to assist the Committee.

The Committee completed its work in June 1948 and the report was forwarded to London with the result that in October Mr. W. W. Reece of the Animal Production Division of the Colonial Development Corporation arrived in the Colony to investigate the proposals on the spot.

One of the areas suggested for investigation was that near Tova in the Province of Ra—between the Kauvadra range in the north and west, the Wainibuka River on the south and approaching closely to the King's road on the east—a total area of some 60,000 acres of grassed hill-slopes and river valleys. The accompanying photographs by Mr. R. Wright of the Public Relations Office, taken from an aircraft chartered on behalf of the Committee, give some indication of the nature of the country.

Fig. 1 covers approximately the south-eastern portion of the area—King's Road may be seen in the mid-foreground with Dobuilevu District Farm (Department of Agriculture) situated at the large bend of the Wainibuka River at its junction with the Dobuilevu Creek The valley of the Upper

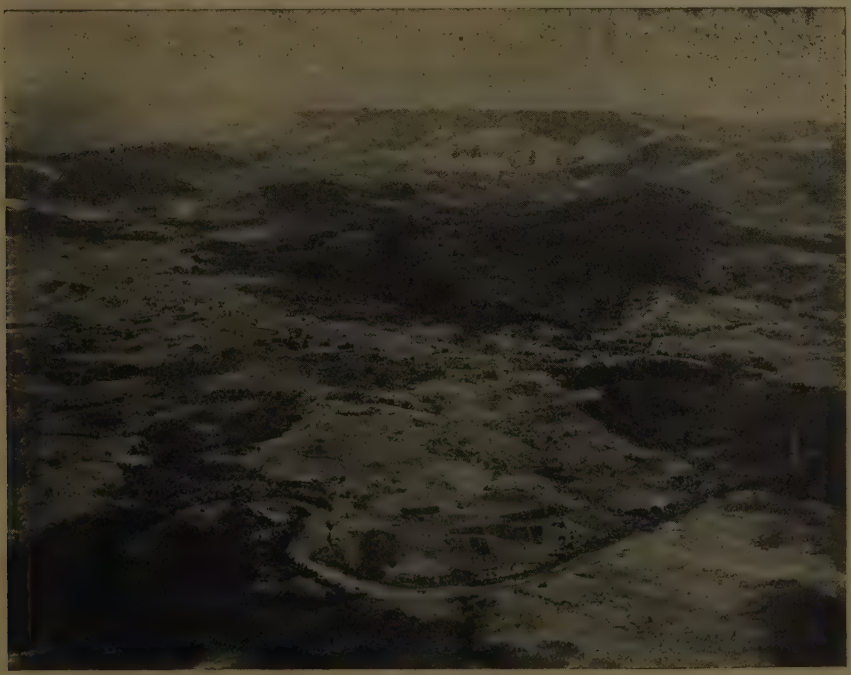

Fig 2: General view of part of area between Wainibuka River (in foreground) and Vitilevu Bay (in top left-hand corner), King's Road and Vunikavikaloa Settlement in mid-distance, Dobuilevu District Farm in bottom right-hand corner.
Photo: Public Relation Office.

Wainibuka is illustrated and the hills in the background are those towards the north and west of the area. It will be seen that the area is well watered and fairly clear of forest growth.

Fig. 2 faces north towards Viti Levu Bay in the background with the main Wainibuka River in the foreground and King's Road winding approximately through the centre of the view. The contoured fields of Dobuilevu Farm may be seen at the right and in the middle foreground are the cultivations of maize, peanuts, rice and kumalas maintained by the Fijian magistrate stationed at Lau village.

Dobuilevu Farm was established in 1938 and has recently been enlarged by the acquisition of 45 acres adjoining. Besides work with arable crops, rice, maize, soya bean, cotton, vegetables and other crops, the Station has dealt with experimental work on bananas—for disease and pest control—plant introduction studies, but considerable attention has been devoted to pasture and fodder work. Established on the farm are the following grasses and legumes: Guatemala grass, Elephant grass (I.C.T.A. strain), Kavirondo Sorghum, Batiki blue grass, Guinea grass, Puero (tropical kudzu), Stylo (tropical lucerne), Acuan or *Desmanthus*. Useful work has been carried out in pasture establishment, weed control and preparation of pen manure under the dry conditions prevailing in the region. Rainfall records have been maintained since an early date. B.E.V.P.

STANDARDIZATION OF SYSTEMS AND METHODS FOR USE IN SOIL SURVEY.

A sub-committee of the West Indies Conference, Second Session, which met in St Thomas, Virgin Islands of the United States, in February-March, 1946, recommended that a conference of Soil Scientists should be held in Puerto Rico in 1948. This conference would be held under the auspices of the Committee of Agriculture, Nutrition, Fisheries and Forestry of the Caribbean Research Council, for the purpose of studying systems and methods of classification and mapping of tropical soils, with special reference to the standardisation of such systems and methods for use in soil surveys throughout the Caribbean region and to carrying out such surveys as soon as possible.

With the establishment of the South Pacific Regional Commission and in view of developments in the South West Pacific the agenda should prove to be of interest in the event of a similar conference of soil scientists from Fiji and the Western Pacific High Commission, Australia, New Zealand, New Guinea and Hawaii. The proposed agenda is:—

(i) Presentation and discussion of collected data on soil forming factors of the various territories.
(ii) Standardisation of field and laboratory methods of soil survey.
(iii) Discussion of different systems of soil classification and mapping.
(iv) Formulation of a detailed regional programme of soil survey.
(v) Survey of problems of soil erosion, soil conservation and soil renovation in the different territories.
(vi) Practical application of soil surveys to land utilization. L.E.S.

THE DAIRY INDUSTRY.

It was announced on September 7th that the Government of Fiji proposes to arrange for a survey of the Colony's dairying industry, with particular reference to the cost of the production of butterfat.

The official statement indicated that it is intended to ask for recommendations for bringing about increased efficiency in the industry and that as dairying conditions in Queensland are generally similar to those in Fiji, to obtain the services of an expert from Queensland to conduct the proposed investigation.

During September the controlled maximum price of locally manufactured butter was increased by 2d. per pound to 2s. 3d. wholesale and 2s. 4d. retail for areas within five miles of the Suva, Navua and Nausori Post Offices, and for other areas 2s. 4d, wholesale and 2s. 8d. retail.

IMPROVING SOIL FERTILITY BY INDIRECT NITROGENOUS MANURING.

BY A. D. MERCER, WEED CONTROL OFFICER.

One of the reasons commonly advanced for the low production of dairy herds in Fiji is a deficiency of protein in the diet. This may or may not be so, it is quite possible the deficiency is simply of diet. The appearance of many grain crops however, and the low yields commonly experienced, do indicate a shortage of available nitrogen, and under present conditions this deficiency cannot directly be met. The available supply of organic manure is, on most holdings, totally insufficient to meet requirements and the cost of inorganic nitrogenous fertilizers is prohibitive. There is however an unlimited, and, as yet, free supply of nitrogen available in the atmosphere which can be drawn on by every farmer and cheaply made available to his crops or pasture by the encouragement and stimulated growth of legumes.

It has long been an established fact, both in the dairying and arable farming areas of New Zealand, that provided attention is given to maintaining phosphate and lime status of the soil, the nitrogen will look after itself. Nitrogenous dressings either to pastures or to cereal crops are the exception, yet the yields recorded from both are as high as any in the world and the area of fertile land is steadily increasing. Soil fertility is maintained, or induced on the poorer soil types, by the application of phosphate to stimulate the growth of various legumes, which in turn ensure an adequate supply of nitrogen either to associated pasture species or to a following grain crop. There is every reason to believe that the application of this method in Fiji could produce comparable results, while present investigations into the possibility of exploiting local deposits of phosphate encourage hopes of its being brought within the economic reach of the farmer. It must be strongly emphasized though that the application of phosphate to lime-deficient soils is a waste of money, particularly on the red clay soils of Fiji, where the phosphate becomes fixed in the form of insoluble salts of iron and alumina, and unavailable to plants. This fixation is not so marked with a raw phosphate rock as would be the case with a superphosphate, but correction of soil acidity by the prior application of lime would still be advisable.

Experiments carried out in United States indicate that for every pound of phosphatic fertiliser applied to a leguminous crop, three pounds of nitrogen are added to the soil. With phosphate containing 20 per cent P_2O_5 at £6 per ton* and sulphate of ammonia containing 20 per cent nitrogen at £24 per ton it follows that every pound of such phosphatic fertiliser applied to a legume will return twelve times its value in nitrogen, through the consequent stimulated growth of the legume, resulting in a greater fixation of atmospheric nitrogen and a greater residue of organic matter in the soil. The building up of soil fertility by this process is practicable either on pasture land or arable.

On Pasture Land.

Most of the dairy pastures of Viti Levu, whether on the flat or on easy hill country, carry a varying association of carpet grass, sour grass, seed grass, inferior species of paspalum, *Desmodium* spp. and sensitive plant, with a number of annual weeds, particularly on the more poorly drained areas. These mixed pastures must be the basis on which to work for any greater production of butterfat, with fodder crops supplementary to them if the labour situation permits.

An adequate supply of nitrogen is essential to grass growth both in quantity and quality. Overseas experience has amply demonstrated that it is most cheaply and easily supplied through stimulation of the associated legume species by the application of phosphate. The grasses and legumes present in the sward will vary according to climatic and soil conditions, and grazing practice, but the principle applies throughout. No reliable information is available concerning the feeding value of the pasture species comprising the

swards of the dairying districts of Viti Levu but general opinion among dairy farmers favours carpet grass (*Axonopus compresses*) as the most useful, while various species of blue grass appear worthy of encouragement. Almost the only pasture legumes present are sensitive plant, the value of which is debatable, and *Desmodium* spp. sometimes known as trefoil, which grows profusely on the thin soils overlying soapstone and in well drained situations generally. This preference for soils of a high lime content suggests that it could quite readily be established elsewhere by drainage and adequate applications of lime. It is palatable to stock, forms a close turf in association with carpet grass under grazing, and under the stimulus of applied phosphate would in its turn stimulate and improve not only the bulk of grass growth but also its nutritive value. Analyses of grass from five experiments in Florida in 1946 showed that the phosphate and calcium content of topdressed carpet grass was increased 78 per cent and 21 per cent respectively over unfertilised grass. The protein content of grass is also increased when growth of the associated legume is intensified.

The application of phosphate thus initiates a cycle of increasing fertility. The direct response of the legume results in increased yield and value of the grasses, permitting increased stocking which in turn results in increased fertility by the addition of humus through the droppings. About 90 per cent of the nitrogen consumed by the mature grazing animal is returned to the soil, and once the phosphate status of the soil has been raised sufficiently by a few years of annual topdressings at 3 to 4 cwt. per acre, subsequent applications may become smaller and less frequent, as the amount of mineral removed annually from the dairy farm is comparatively small. An annual production of 150 lb of butterfat per acre removes in milk the equivalent of—

41 lb superphosphate.
26 lb 30 per cent potash salt.
10 lb lime.

Where the skim milk is fed to pigs on the farm even the major part of this loss is returned to the soil. Provided the phosphate is applied as required the cycle of increasing fertility through vigorous legumes, better grass, heavier stocking, more manure, can be maintained indefinitely.

Certain proved practices of grassland management must go hand in hand with a fertilising programme. These are briefly—

(*a*) Heavy concentrations of stock on small areas for short periods; complete spelling between grazings.

(*b*) Topping with the mower periodically to prevent seeding of inferior annual grasses and weeds, and to keep down rank growth

(*c*) Light harrowing after stock are removed to spread manure and prevent growth of rank unpalatable rings around the droppings.

Carpet grass and desmodium, the most desirable constituents of these mixed pastures, are not dependent on seeding alone for their propagation, as are some of the inferior grasses and weeds, so that the adoption of the practices outlined will result in the stimulation of these species and the eventual suppression of the less desirable. Improvements of existing pastures by the encouragement of the more desirable species known to thrive under local conditions is the easiest and most obvious first step towards increased production per acre.

On Arable Land.

In the production of profitable crops of grain, or leaf vegetables, ample supplies of available nitrogen are essential, yet blood and bone fertiliser is unprocurable and supplies of farmyard manure are totally inadequate to meet the need. Leguminous crops are commonly grown at some stage in the rotation for this purpose, and their marked response to phosphatic fertiliser, by stimulating growth of the crop, leads to increased nitrogen fixation and greater bulk of organic matter added to the soil for the benefit of a succeeding cash crop. The legume crop may be utilized to raise soil fertility either by ploughing in as green manure. by feeding off by stock on the land or by cutting and feeding to stock as supplementary rations.

If ploughed in it should be at the flowering stage, and sufficient time should be allowed for rotting of the material and incorporation

with the soil before sowing the following crop, as the gases given off during decomposition are injurious to seed germination.

If the crop is grazed by stock it should be fed off in small breaks by heavy concentrations to ensure maximum utilisation.

If cut and fed to stock they should be confined in a yard or pen and the manure carted out as required.

The increased vigour of a legume crop resulting from applications of phosphate leads not only to an increase in bulk but also to a higher phosphate and protein content for the benefit of stock consuming it.

SUMMARY.

An adequate supply of available nitrogen is essential to the vigorous growth of grasses and grain crops.

The cheapest method of supplying it is by stimulating the growth of legumes with phosphatic fertiliser, preceded by a dressing of lime, i.e. three tons coral sand per acre.

Of the native pasture species, carpet grass and desmodium offer the most promising basis on which to work for improvement. They grow naturally in soil conditions which can be induced on other areas by drainage and topdressing. Phosphatic fertiliser improves the nutritive value of pasture grasses and legumes and by stimulating the more desirable species assists in the control of inferior grasses and weeds. On pasture land phosphate should be applied at the rate of 3–4 cwt. per acre annually for three years in the month of April–May.

On arable land, phosphate applied at the same rate per acre to a legume, either for ploughing in or feeding off, will increase the supply of available nitrogen and organic matter for the benefit of a succeeding crop.

As long as the necessary phosphate is applied and utilised in this manner, the supply of nitrogen may be left to take care of itself.

*£6 per ton is an arbitrary statement of a possible price for Lau phosphate in Viti Levu.

OVERSEAS VISITORS.

Dr K. B. Cumberland, head of the geography department of Auckland University College, paid a protracted visit to Fiji and other S.W. Pacific Groups, extending from August to the end of October. Dr. Cumberland's purpose was to make "a reasonably simple survey, on a geographical basis, of the islands which are linked with N.Z. by direct political, strategic, social and economic commitments." He intended paying particular attention to the land and agricultural problems of the population, and hoped to be able to gauge the effect of the war on the production of the islands. Of especial interest to residents of Fiji are Dr. Cumberland's impressions of the soil erosion problem in this country—a subject on which he is an expert. An extract on this aspect of his investigations is reproduced from the *Fiji Times and Herald* on page 73 of this number, and an article contributed by him dealing with agricultural problems in the S.W. Pacific generally appears on page 63.

Mr. W. W. Reece of the Colonial Development Corporation arrived in Fiji on 18th October to investigate the proposed Fijian Pastoral Development Scheme. During the ensuing ten weeks he visited, in company with Departmental officers, many parts of the Colony and travelled extensively in the Provinces of Ra, Nadroga-Navosa in Viti Levu and Macuata (Seaqaqa) in Vanua Levu. He also made several aerial surveys. He met the members of the Pastoral Development Committee and also many members of the general public who are interested in animal production. Mr. Reece left the Colony on 29th December by air via Honolulu to London.

CONTROL OF WATER HYACINTH (EICHORNIA CRASSIPES) IN THE REWA DELTA.

BY A. D. MERCER.

For a number of years the growth of water hyacinth in the waterways of the Rewa delta has been a matter of serious concern to the Rewa River Board and to the officers and cane growers of the Colonial Sugar Refining Company Ltd.; to the former as a hindrance to navigation in the smaller channels giving access to native villages, and to the latter as both seriously impeding the drainage of large cane areas and hindering the transport of cane by water. In some waterways a chain in width and six feet deep, the growth of water hyacinth made it possible to cross on foot from bank to bank. Large sums were expended annually in efforts to keep the channels clear but reinfestation soon followed each clearing. For a time the weed was pulled out, dumped in barges and towed out to sea, but more recently the practice has been to drag it from the water and leave it on the banks to die. The work was laborious and costly, some stretches costing £150 per mile for merely temporary relief of the situation.

Early experiments with new weedicides in 1946, reported in the *Agricultural Journal* of June, 1947, indicated that water hyacinth was very susceptible to either the 2, 4-D or the Methoxone type of weedkiller applied as a 1½ per cent spray. It was also demonstrated that the cost of securing a complete kill was vey much less than the cost of the purely temporary measures previously adopted. Although the economic use of these weedicides in ordinary farming practice is strictly limited, and their employment no substitute for good husbandry, no other method had proved as cheap or efficient in dealing with water hyacinth. Accordingly arrangements were made with the Rewa River Board and the Colonial Sugar Refining Co. Ltd. for concerted action against the weed in all the waterways of the Rewa delta to commence in April, 1948, the Department of Agriculture carrying out the work, in that area allotted to the River Board, on the Board's behalf. This involved the clearing of the following channels.

Main river from Naduruloulou to Lomanikoro; Toga river; Qaraniki creek, Wainibokasi river; Burebasaga or Naqio creek; Lokia creek; Draubuta-Nakaile creek.

The total length of waterway was 30 miles, and the infestation varied from small isolated patches on the banks of the main river to complete blockage, somteimes a chain in width, in the small rivers.

Continued wet weather made it impossible to start work in April, while in May operations were carried out for one week only, most of the work being eventually done from 16th June to 16th July.

Four men in the charge of a Field Assistant were employed, having the use of a launch and small boat, with three gallon knapsack sprayers for the men working along the banks and a four gallon sprayer operated from the boat in deep water. In some places the use of 12 foot lengths of 9″ x 1″ planks laid on the mass of weed enabled men to work from the banks out to deep water.

The most readily available of the hormone weedkillers at this time was Weedone, and this was used throughout as a 1½ per cent spray, i.e. six ounces to each three gallon sprayer of water, though some preliminary work carried out in February indicated that in hot weather, with plants growing vigorously, one per cent spray was effective. In some rivers, masses of the weed, large and small, travelled up and down the stream with each tide, and an incoming tide at night would carry unsprayed material into the stretch which had been completed by day, with the possibility of some of it lodging there. This elusive quality of the hyacinth, in which respect it rivals the Pimpernel, entailed a watch being kept on areas which might otherwise have been presumed to be clear. In some places it was possible to rig a floating boom across the river at the end of the day's operations and thus prevent this nocturnal infiltration.

The first spraying was completed on the 16th July and resulted in about 75 per cent kill. In dense stands of weed up to three feet high a number to the smaller plants survived, while some of the moving masses apparently escaped the sprayers.

For the first spraying of 30 miles of waterway the costs were as follows:—

LABOUR—						
4 men at 5s. 7d. for 30 days ..	..	£33	10	0		
Supervision	..	17	10	0		
					£51	0 0
WEEDONE—						
33 gallons at 25s.	..	..			41	5 0
LAUNCH—						
Petrol and oil ..	..	..			4	7 0
					£96	12 0

The second spraying was carried out between July 26th and August 26th at the following costs; including two additional small creeks.

LABOUR—						
65 units at 5s. 7d. .		£18	3	0		
Supervision	..	10	0	0		
					28	3 0
WEEDONE—						
14 gallons at 25s.	..	..			17	10 0
TRANSPORT—						
Petrol and oil ..	..	..			3	10 0
					£49	3 0

Total cost of two sprayings=£145 15 0.

Average cost per mile=£5.

The cost per acre of weed would also be approximately £5 where no travelling is involved.

In such an extensive system of river channels there are sure to be some plants still surviving which, if neglected, would lead to re-infestation, but a patrol of the rivers at intervals over the next year could deal with any signs of re-establishment at little cost.

N.Z. EXPERTS SURVEY OF SOIL EROSION MENACE.

After years of indifference, many people in Fiji—but not all—are at last awake to the grim menace of soil erosion.

There are tragic examples of erosion in the Suva area and other parts of the Colony—many of them the result of ruthless exploitation of land—and the danger is being given more publicity now than ever before.

PAPER BY EXPERT.

On Monday evening Professor K. B. Cumberland, of Auckland University College will read a paper to the Fiji Society on the subject of erosion.

Professor Cumberland, who is the author of a book, "Soil Erosion in New Zealand" has been travelling in Fiji and other island groups for two months.

The following extract from the book sums up the situation:

"Soil conservation is not only technically possible, but economically desirable and socially imperative. Productive soil is vanishing the world over.

"There are in the world two food-producing acres per person. Some countries have less than one a head.

"That one acre is often of low fertility or is being maltreated and eroded. Yet nutritionists say that a minimum of two and a half acres a head of good land are necessary to produce a minimum adequate diet.

"The difference between the current and the desirable averages is half an acre.

"This has to be multiplied by 2,000,000,000. It means that either 1,000,000,000 new acres must be brought into food production or else the productivity of the 4,000,000,000 acres now under grass or food crops must be stepped up by 25 per cent. The latter seems more feasible."

AUSTRALIAN SUPPORT.

Dr. Graham Andrew, one of Australia's medical representatives on UNRRA supports these views as follows:

"Recent reliable figures indicate that 800,000,000 of the world's population are short of food and that the terrifying figure of 300,000,000 are living on a diet of 1000 calories a day or less."

From *Fiji Times & Herald*, 25th Sept., 1948.

PRODUCE IMPORTS AND EXPORTS.

PRODUCE RETURN (IMPORTS AND EXPORTS) FOR THREE MONTHS ENDING 30TH SEPTEMBER 1948.

Imports.	Quantity.	New Zealand.		Australian.		Other countries.		Total Value.	
		Imports	Exports	Imports	Exports	Imports	Exports	Imports	Exports
		£	£	£	£	£	£	£	£
Australia—									
Fresh Fruits ..	23,888 lbs	....	....	586	....	....	....	586	....
New Zealand—									
Fresh Fruits ..	135,475 „	3,200	....	....	....	....	....	3,200	....
Australia—									
Vegetables ..	2,864 „	....	....	115	....	....	....	115	....
New Zealand—									
Vegetables ..	32,426 „	570	....	....	....	....	....	570	....
Australia—									
Onions	120,379 „	....	....	1,222	....	....	....	1,222	....
New Zealand—									
Onions	713,337 „	8,300	....	....	....	....	....	8,300	....
Australia—									
Potatoes ..	260,167 „	....	....	2,273	....	....	....	2,273	....
New Zealand—									
Potatoes ..	1,622,911 „	14,076	....	....	....	....	....	14,076	....
Spices	84,503 „	202	....	1,043	....	4,068	....	5,313	....
Exports									
United Kingdom—									
Copra	4,226 tons	....	....	....	....	....	209,733	....	209,733
Coconut Oil ..	1,941 „	....	....	....	....	....	169,729	....	169,729
New Zealand—									
Bananas	2,536,290 lbs.	....	18,963	....	....	....	....	....	18,963
Canada—									
Bananas	17,698 „	....	....	....	....	....	397	....	397
New Zealand—									
Pineapples ..	1,320 „	....	14	....	....	....	....	....	14
Mixed Fruits ..	6,660 „	....	84	....	....	....	....	....	84
Peanuts.. ..	67,100 „	....	2,238	....	....	....	....	....	2,238
Green Ginger ..	107,550 „	....	1,793	....	....	....	....	....	1,793
Taro	7,520 „	....	42	....	....	....	....	....	42
Arrowroots ..	2,080 „	....	65	....	....	....	....	....	65
Coconut Meal ..	502,000 „	....	2,695	....	....	....	....	....	2,695
Yams	240 „	....	2	....	....	....	....	....	2
Rice Bran ..	324,000 „	....	1,800	....	....	....	....	....	1,800
Oranges.. ..	1,300 „	....	17	....	....	....	....	....	17
Samoa—									
Peanuts.. ..	3,500 „	....	....	....	....	....	117	....	117
N'Caledonia—									
Peanuts.. ..	6,720 „	....	....	....	....	....	336	....	336
Australia—									
Green Ginger ..	9,150 „	....	....	....	153	....	....	....	153
		26,348	27,713	5,239	153	4,068	380,312	35,655	408,178

NOTE.—The following Commodities are not included:—Flour, Sharps, Rice and Sugar. B.A.K.

LUVULUVU RICE AREA.

With the object of making additional land available for rice growing to help relieve the shortage, negotiations were entered into in 1947 to make available to Indian farmers, certain areas of the Nausori Aerodrome which were adjacent to runways but not actually in use. Noxious weeds were taking possession and the land was non-productive. The areas were sub-divided into blocks of 2 to 4 acres and on 13th November, 1947 the blocks were distributed. 29 blocks comprising 91 acres were distributed among 64 applicants. There were many applications received and blocks were allotted as far as possible to those who had no land for rice production. Some of the blocks were divided between relatives or close friends sharing and cultivating in one block.

During the first year many visits were paid to the area for recording progress of the scheme and settling minor disputes that arose concerning cattle damage, trespass, rights of way etc., but on the whole work proceeded smoothly.

Farmers had struggled hard to get the bush cleared and ploughed although the blocks were given to them when it was too late for preparation. Some got the land planted by broad-casting seeds, and some tried their best to raise seedlings and borrow seedlings from other farmers to transplant.

Item.	Other Crops grown.	Average yield per acre.
Vegetables	·2 acres	...
Pulses—		
Cowpea	4·2 „	1,800 lbs.
Mungh	3·15 „	600 „
Urid	4·6 „	500 „
Mixed pulses	4·3 „	650 „
	16·25 acres	
Spices—		
Coriander	2·2 acres	400 „
Roots—		
Cassava	·8 acres *	
Kumala	·8 „	6 tons
Dalo	·1 „	6 „
	1·7 acres	
Off season rice.		
New Guinea	2·0 acres*	
Sonacalif	·3 „*	
	2·3 acres	

*Not harvested yet.

In June 1948 an extension of time was granted to occupiers and by September they were confirmed in their holdings until 30th June, 1949. Some blocks had to be re-allocated and allowances made for metalled roads through some blocks to hurricane shelters for planes. Drains were kept in order by the aerodrome authorities and the whole area now appears productive and fairly clear of weeds. Before and after cropping there had been good grazing for the growers cattle.

SUMMARY OF CROPS.

RICE, SEASON 1947–48.

Varieties.	Transplant. ac.	Drilled. ac.	Broadcast. ac.	Total. ac.	Yield. bush.
China Patna	22·6	0·2	12·75	35·55	1,335
Ram Cajara	11·2	..	....	11·2	522
New Guinea	2·75	..	0·7	3·45	108
Saraya	0·3	..	....	0·3	12
Kandala	....	..	0·1	0·1	3
Total . ..	36·85	0·2	13·55	50·6	1,980

Total padi produced by 49 growers= 44 tons 4 cwt. at an average yield of 39·1 bushels (1955 lb) per acre.

At the present the area is in good condition and ready ploughed for another crop of rice.

M. Subramani

ANIMAL HUSBANDRY . . .

TWO IMPORTANT FACTORS IN LOCAL MILK PRODUCTION.

BY R. V. SANDERS, B.V.Sc.

In a previous article the Animal Husbandry Officer dealt with the inadequacy of para grass as the sole ration for dairy stock. In the present article attention is directed to the constituents of pasture which are of importance in nutrition and the fact that many other grasses and legumes introduced by the Department of Agriculture have a higher protein equivalent than para. From recorded analyses of Kudzu and para, the Animal Husbandry Officer determines that 40 lbs. *of para grass and* 35 lbs. *of Kudzu give a balanced ration with a nutritive ratio of* 1: 7·4. *The amounts of other legumes required to replace Kudzu and give a similar nutritive ratio are also set out. The two limiting factors for livestock raising in the tropics are the inadequacy of digestible protein per acre under normal rough grazing and hand feeding conditions and the regression from type of high yielding imported strains of European livestock unsuited physiologically to the climatic environment. Methods of improvement by management and study are foreshadowed in this paper.—Ed.*]

There is a tendency for local farmers to over-stress the importance of importing high-producing strains of pure-bred dairy cattle as a means of increasing local production. There are certain local environmental factors which would prevent this solution of low milk production from being completely successful. Without detracting from the importance of selection and breeding for high production, there are very definite limitations to the expectation of high-producing qualities being reproduced over a wide range of environment. Livestock, no matter whether it be poultry, pigs, goats, beef or dairy cattle, have been brought to a high pitch of efficiency by selection under a certain set of environmental conditions, and unless those conditions can be duplicated in any new area the animals will not live up to their genetic capabilities. One does not import high producing stock, but stock capable of high production provided they are given a suitable environment. McMeekan(4) has stated " environment controls the extent to which hereditary qualities develop. . . . In most productive qualities of the animal, such as milking-ability meat-quality, and wool-quality, environment exerts a powerful effect ". Therefore if the importation of pure-bred cattle from New Zealand or Australia is to be expected to raise our local milk production to any appreciable extent, these cattle and their progeny must be given similar environment conditions to those under which they were selected for high production.

Nutrition and climate have been proved in many parts of the world to be two of the major environmental factors affecting milk production. Though it may be possible to alter our standard of nutrition for dairy cattle, there is little that can be done as regards climate. Pure-bred European-type cattle have not been successfully adapted to true tropical conditions. Kelly(3) explains it in this manner " the fundamental disability of European cattle within the tropics is the inferiority of their heat-regulating mechanism. It is incapable of maintaining the body temperatures at normal levels when the animal is exposed to high atmospheric temperatures. French and other workers have shown that this weakness persists and is detrimental to the cattle even when they are adequately fed." Nichols(6) refers to pure-bred temperate breeds of cattle when he states " It appears that degeneration as a result of high temperatures and small fluctuations will occur generally in areas of the world lying between north and south isotherms of average yearly temperature 68, except where the altitude is over 3,500 feet or local geographical factors produce cooler conditions. Exotic breeds in these areas will degenerate even if well fed." The same author also states " numerous examples are found of the failure of dairy cattle of temperate climate origin to improve native types in the tropics and subtropics, because the constitution of the grades is inadequate to sustain increased production in the tropical environment."

Hammond(2) gives an example of this " The Indian Army Dairy Farms obtained such a striking improvement by making crosses of the native cows with imported Ayrshire and Friesian bulls that they continued the introduction of European blood. There came a time, however, when the percentage of European blood became too high and then production fell instead of increasing; this was confirmed by results in Brazil, Africa, and the West Indies. By introducing into this degenerate stock more Zebu blood, a constitution suited to the tropics, production is increased." This is one explanation why local farmers with European-type cattle which degenerate rapidly find that milk yields are low. Farmers with temperate zone type cattle should consider the matter very carefully before outlaying money on imported cattle if this means is to be their sole endeavour to increase milk production. Their chances of success will be very slight. The possible solution of this adverse climatic factor is given by Nicholas(6) as " (*a*) Selection and pure breeding among the native Zebus, (*b*) degrading some of the high grades with Zebu bulls towards the level at which inferior animals do not appear, but with selected superior native cows continually introduced for grading up, or (*c*) inbreeding at this level and culling undesirable progeny."

This still leaves the other major environmental factor of nutrition. It has been shown(9) how the para grass and coconut meal mixture which is commonly used in Fiji is inadequate for full milk production. There are variations of this ration and all of them fall short of what is required for production. Poor nutrition is responsible for a lot of low milk production especially in those herds with varying amounts of Zebu blood. Unlike climate, nutrition can, within certain limits, be controlled. There is still a lot to be learnt as regards feeding of dairy cattle under tropical conditions but in recent years there has been a great advancement, particularly as regards the development of tropical legumes. In addition to these legumes, there are certain grasses available with protein figures superior to those of para grass which is so frequently the mainstay of local pastures.

Farmers are frequently unable to differentiate between the different methods used to describe the protein content of a food and because of this get the wrong impression of the relative value of any particular fodder. The most commonly confused terms are " percentage protein dried weight ", " percentage protein of the fresh fodder ", and, " percentage digestible protein ". The relative amount of protein in a fresh fodder is less in proportion to all other constitutents than that of a dried sample. This is perhaps best explained by taking 100 pounds of fresh para grass which contains 1·7 per cent or 1·7 pounds of protein. The first process in making an analysis is to drive off all the water, which in the case of fresh para grass weighing 100 pounds would amount to about 73 pounds leaving approximately 27 pounds of dry matter. The latter would still contain 1·7 pounds of protein but this protein would amount to 6·25 per cent of the dried material. Thus from the fresh to the dried state the percentage of protein is raised from 1·7 to 6·25 though it still contains the same weight of protein in respect of the original 100 pounds of cut grass. During the process of mastication and absorption some of this protein is lost to the animal. The amount of loss or wastage varies with the fodder. In the case of para grass about 41 per cent of the protein is wasted. Thus of the original 100 pounds of para grass with a protein content of 1·7 per cent and a dried weight protein content of 6·25 per cent only one per cent could actually be utilised by a cow as digestible protein. The figures above are for para grass grown overseas(5). Recent analyses(1) of local samples of para show great variation, all of which are inferior to those quoted above and are as follows: protein content 2·6 to 5·5 per cent dried weight which equals 0·7 to 1·5 per cent of the fresh grass or 0·4 to 0·88 per cent digestible protein.

In contrast to the digestible protein content of para grass 1·0 per cent (overseas) and 0·4 to 0·88 per cent (local) there are many other fodders available locally which have a far better percentage. Some examples of these are Guinea grass 1·1, elephant grass 1·4, kudzu 4·2, centro 3·9, puero 3·6, stylo and soyabean 3·2, vaivai

2·9, Mauritius bean 2·6, and cowpea 2·3 (all expressed as percentage of digestible protein). Full analytical data for all of these fodders is not available. Since full data(5) is available for kudzu it is used in the following example of how a local milking cow's ration can be balanced though kudzu has not been very successful as a crop in Fiji to date. For all practical purposes the feeding value of the other fodders mentioned will vary in approximately the same proportion as their protein content. That is to say that since the protein equivalent (mean of digestible true protein and digestible crude protein) of kudzu, with a digestible protein content of 4·2 per cent, is 3·3, then puero with a digestible protein content of 3·6 may be expected to have a protein content of approximately 2·8 per cent or not quite so good as kudzu. It must be clearly understood that this method of estimating the protein equivalent of local fodders is not strictly accurate. It is only approximate, but will suffice for all practical purposes until the more accurate averages have been derived by complete analysis and experimentation. As it may be a long time, possibly years, before these figures are available, it is felt that the approximate figures will give farmers some immediate indication of the relative value of the different fodders and the approximate amounts they should feed. The present dairy cow ration is so lacking in protein equivalent and is so badly balanced that any slight error in making an approximation will be insignificant in the final result. Even figures obtained by analysis and experimentation are only averages when related to what is actually utilised by the cow. This is because of the great variations in protein content within any plant species with district, soil, management, and season. As has been shown above there is over 100 per cent variation in the protein content of local para grass, the only variable being the season.

It has been stated(9) that a cow weighing 900 pounds yielding two gallons of milk daily with a butterfat test of 3·5 per cent requires a daily ration of 20·5 pounds of dry matter 10·5 pounds starch equivalent, and 1·55 pounds protein equivalent with a nutritive ratio of under 1: 7·8. A daily ration of 150 pounds of fresh para grass contains 40·6 pounds dry matter 18·75 pounds starch equivalent, and 1·5 pounds protein equivalent. There is an excess of both dry matter and starch equivalent but insufficient protein equivalent for maximum production. The nutritive ratio of 1: 14·5 is also far too wide and would prevent the full amount of protein from being available to the cow. What difference would be made to the ration if kudzu was added?

	Dry matter.	Starch Equivalent.	Protein Equivalent.	Nutritive Ratio.
	lb.	lb.	lb.	
40 lb para grass	10·88	6·0	0·4	....
35 lb kudzu ..	10·71	4·57	1·15	....
	21·59	10·57	1·55	1 : 7·4

This would be a balanced ration for the type of cow mentioned above. In other words the amount of para grazing may be cut by more than two-thirds. The 35 pounds kudzu may be replaced by any one of the following fodders to supply the same quantity of protein equivalent:—

38 pounds centro.
41 ,, puero.
48 ,, stylo.
48 ,, soyabean.
50 ,, vaivai.
57 ,, Mauritius bean.
63 ,, cowpea.

If two pounds of coconut meal is fed the para grass may be increased to 50 pounds and Mauritius bean reduced from 57 to 30 pounds to give a balanced ration for a two gallon 900 pound cow. If the cow only produced one gallon of milk daily her daily requirements would be 20·5 pounds dry matter, 8 pounds starch equivalent, and 1·05 pounds protien equivalent. Except for a slight deficiency in dry matter which if not nearly so important as even smaller quantities of protein equivalent, the following ration would be adequate:—

50 pounds para grass.
30 ,, Mauritius bean.
1 pound coconut meal.

Thus the difference between a 900 pound cow giving one gallon daily and one giving two gallons can be made up by the addition of one pound coconut meal to the para-Mauritius bean mixture above. The nutritive ratio for the ration with one pound coconut meal is 1: 7·5 and that with two pounds meal 1: 7·2, both within the range needed. The addition of a third pound of coconut meal would not make the mixture suitable for a three gallon cow. Such a cow would need 50 pounds para, 50 pounds Mauritius been and two pounds coconut meal which would provide the required amount of protein equivalent of two pounds and a suitable nutritive ratio of 1: 6·4.

There is more to this than giving a herd a balanced ration and so making them capable of maximum production. Take the instance of a farmer with twenty-five milkers each about 900 pounds live weight and with an average of two gallons milk daily. This herd may be expected with ordinary para grazing to consume about 150 pounds para daily. If this farmer decided to change to the mixture 50 pounds para, 30 pounds Mauritius bean, and two pounds coconut meal each daily, not only would he get a greatly increased supply of milk but he would also effect a great saving in land, drainage, and fencing. His para grazing could be cut down by two-thirds. Fair crops of Mauritius bean at the departmental Sigatoka station yield twelve tons of green fodder per acre. As 25 cows would need 750 pounds bean daily, one acre would provide sufficient legume fodder for about 35 days or eleven acres would keep the herd going for the whole year. In this manner the farmer would have a great saving of land, and, if properly managed the costs of producing the bean crop would be more than offset by the saving of fencing and draining maintenance costs to say nothing of the increase in yield.

Farmers will immediately raise the point as to the most economic method of providing this legume fodder. Obviously the method will vary with the type of farm, soil, and district. What would be practicable for a small peasant farmer may not be for a large property and vice versa. Similarly methods that would apply for the wet zone may not be adaptable for the dry zone. Local experience on the different methods has not yet been developed to the stage where any hard and fast rules or procedures can be advised but the general principles can be described and adaptations for the particular property can be made by the farmer himself.

Grazing is the most economical method of feeding in most dairy countries. In temperate zones a good pasture alone can provide a fully balanced ration for dairy cattle. There are no known pastures of such good quality in Fiji. As para grass tends to predominate in most of these pastures, a solution may possibly be found by either different methods of managing para, mixing it with other grasses and legumes, or replacing it entirely with other pasture mixtures. The protein content of pastures in other countries has been increased by rotational grazing, top-dressing, drainage, etc. Similar increases might be possible if para is treated likewise. There is an indication however that it will not be possible to raise economically the level of protein in local para as high as some other grasses. Local para is already lower in protein content compared with overseas para which itself is still too deficient to be considered as an advisable predominant grass in a pasture. Improved methods possibly will only bring the local para to the latter level. Experienced farmers in north Queensland have swung away from para grass to mixtures with Guinea grass predominating ([10]). Guinea grass has a slightly higher protein content than para. Other grasses with even better possibilities are now under study by the local department. During the 1946 season on the Sigatoka station the seasonal drop in milk production amounted to 52·4 per cent of the peak production. This serious loss is associated with a well defined season and is not necessarily associated with dry weather([11]). This drop may coincide with the dormant stage of grass growth. This is a common feature of most grasses. It is for this reason that first class overseas pastures consist either of grass mixtures or grasses mixed with legumes. The object is to have a more or less continuous supply of good quality fodder the whole year round.

One season will favour one or more species until the next season when they start to regress and other species in the sward are favoured. It is for this reason that the local practice of having production dependant upon one predominate grass is to be condemned in the absence of any form of fodder conservation. In north Queensland[10] there are excellent mixed pastures of Guinea grass and centro, other farmers had combined such grasses as Guinea, molasses, and Kenya couch with success. When one considers that centro has more than three times the feeding value of para grass its establishment must be more than offset by savings in maintaining the present large areas of para.

It may not be practicable for some farmers to establish mixed pastures as suggested and these people would have to go to a little more trouble and expense. Steep hill land is at times rather difficult to grass satisfactorily but will grow vaivai. Provided the vaivai is not permitted to develop to the tree stage and so be out of reach of cattle it can form an excellent fodder to be grazed on land that may otherwise be considered waste land. It is practicable in some areas to cultivate such crops as Mauritius bean, cowpea, puero, etc. Farmers, mostly larger peasant farmers, who have to handle their cows regularly other than at milking could give the cows an hour or so each day grazing the pure legume crop. This method has limitations in that in the case of bean and pea frequent plantings have to be made. Further stylo is rather unpalatable during the period of maximum leaf growth. At Sigatoka cows will not graze a pure stand of stylo at this stage though they eat the same stylo readily if it is chopped and handfed. Other farmers would not find it convenient to handle their cattle on two extra occasions during the day. Such people would have no alternative but to grow annual legume crops during the most favourable time of the year and store it either as silage or hay.

Smaller dairies can, of course, hand feed the fresh legume. Few people realise the enormous amount of milk and ghee produced collectively by the small peasant farmer who owns anything from one to twenty head of cattle. Some of them only manage to supply their own large family with milk products. Many more manage to produce a surplus. The greatest number of such farmers are in the dry zone of Viti Levu and practically all of them have to hand feed their cattle for some portion of the year. This fodder is usually pure para either cut from drains or specially cultivated patches. During the dry season cane tops frequently replace the para grass. Though cane tops may keep a large number of stock alive, the terrific loss in production can only be appreciated when it is realised that the digestible protein content of cane tops is 0·6 per cent or a little more than half as good as para which is itself poor in protein. When the following comparison is considered the weakness of the present methods is well demonstrated:—

	equals lbs. canetops.	or almost lbs. para.
1 lb centro	6½	4
1 lb puero	6	3½
1 lb stylo	5	3
1 lb soybean	5	3
1 lb vaivai almost	5	3
1 lb Mauritius bean	4	2½
1 lb cowpea almost	4	2
1 lb elephant grass	2	1½

If farmers were to feed the same weight of one of the better fodders they would give their cows a better chance of attaining their maximum production than they have on the existing ration of inferior food. Hand feeding of green fodder as it is commonly practised in Fiji is not profitable for larger farmers. The handfeeding of some of the better fodders would bring this practice within the economics of a wider range of farmers.

In instances where it would be impracticable to either graze or hand feed fresh legume fodder conservation is the only solution. The silo offers perhaps the most reliable method in this Colony though hay in the drier zones is a possibility. The initial cost of a silo may appear rather prohibitive to most farmers. The frequent mistake is to judge one's ability to afford a silo on existing returns rather than on the improved returns that will eventuate from feeding a balanced ration. The type of silo will naturally vary with the type of

farm. It would be wrong to expect the small peasant farmer to invest in an elaborate tower silo, but depending upon the size of his herd he could have a pit silo such as was successfully tried out by the department at Sigatoka a few years ago. Some of the older Indians in Fiji have had actual hay-making experience in India but do not practice it in Fiji because others do not. It is not suggested that silage be fed the whole year round. It would be most beneficial during those months when production drops and its feeding should prevent the great seasonal losses now experienced. Since our pastures are generally inferior to those overseas our ensilage in Fiji would have to contain a high percentage of the better legumes to make up this deficiency otherwise the outlay on the production of ensilage would not be warranted. Cattle do not usually take to ensilage readily when it is first fed. But if it is fed initially in small quantities mixed with other food cattle will cultivate a taste for it after a short while and then relish it. There is a tendency for ensilage to taint the milk if it is fed shortly before milking and for this reason it is best fed after milking.

Farmers should be able to make their own adaptations of the general principles that have been suggested above. They should not give up in despair if cows do not show rapid improvement. Bonnier(7) proved with identical twin cows in Sweden that if a beast has been on a protein deficient diet for a long period, it may take her a complete lactation on the improved diet to build up her deficient body reserves of protein before there can be any marked improvement in milk production. On the other hand the marked improvement that may be expected over a year or more is well illustrated by an example in Kenya described by Nightingale(8). Over a two year period with improved management of pastures costing £191 the land area was reduced by 200 acres, the milkers increased from 89 to 113 and there was an increase of 20,345 gallons of milk in the second year.

Better feeding will bring about increased production but while the local industry stocks its herds with pure or grade temperate zone cattle it cannot hope to expect to attain the same high production as they would produce were they in the same country from which they or their ancestors came due to the climatic factor. The only solution to this is to breed cattle which are physiologically suited to hot weather.

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FIJIAN TEACHERS' CONFERENCE.

During December, the Fijian teachers of the Colony held a conference at the Teachers' Training College when a wide range of subjects was discussed. Officers of the Department of Agriculture much appreciated the opportunity to address the conference. The Senior Agricultural Officer spoke on agriculture and the cooperative movement in Fiji and the Senior Livestock Officer on animal husbandry with special reference to the need for supplies of fresh milk in the villages.

CHEMISTRY . . . .

SOIL SCIENCE IN FIJI—PART V AND VI.

PROBLEMS OF SOIL CLASSIFICATION IN FIJI.

BY L. E. SMYTHE, M.Sc., A.R.I.C., A.A.C.I.

Soil science is not behind the other sciences in that the past 50 years has produced an abundance of excellent technical books. These books, naturally enough, deal mainly with problems of soil classification in temperate countries, for it was in temperate countries that the scientific study of the soil developed and research facilities were readily available for such work.

In tropical countries, contributions to our knowledge of soil science have been on a much smaller scale as compared with those of England, the United States of America and Russia. In fact, it is safe to say, that there are at present fewer than six good works on tropical soil science suitable for research workers and agriculturalists in the tropics. The most prominent workers associated with research on tropical soil science include Mohr[1], Milne[2], Pendelton[3], and Hardy[4]. In this connexion the most important research has been carried out in the Netherlands East Indies, Malaya, Hawaii, and the British West Indies.

With world attention at present focused on the role of tropical countries in increased agricultural production, more staff, facilities, and finance are available for research on tropical soil science. Of utmost importance is the recognition by the agriculturalist in the tropics, of the present status of tropical soil science and the problems yet awaiting solution.

Earlier articles in this series have outlined some of the applications of soil science in Fiji agriculture. However, it should be borne in mind that these articles presented only some of the elementary aspects of soil science in Fiji, and that techniques and methods described, by no means represent the ultimate in such a science. In fact, there are a great many interesting possibilities and difficulties which require reckoning with, and some of these will be examined in order to illustrate that we must employ an essentially dynamic scientific approach; that is, an approach capable of changing as the information unfolds.

The great majority of the soil scientists of the past fifty years have concentrated on the identification, description and mapping of soils. These detailed descriptions of soil types investigated, embrace many hundreds of papers and soil maps. Present day leaders in field soil studies are continuing along the same lines. It is most important, however, to observe that classification is not the only means of systematization. Many scientists will realise that data may be organized by means of laws and theories, as in fact has been the case with the chemical, physical and certain branches of the biological sciences.

As Bushnell[5] has pointed out, characteristics and types of soils form a continuous spectrum and the breaking up of this band into classes, is quite an arbitary procedure. This is borne out by the existence of perhaps a hundred different schemes for soil classification, each of which may have its own particular merits for the region studied, but none of which may be taken at random and applied to any given case. It is not uncommon to hear agriculturalists, impressed with some system of soil classification, point out that with soil maps depicting the distribution of soil types on a scale of 16 chains to the inch, they have the panacea for agricultural planning. However, comparatively few soil types may be mapped with such accuracy at the present stage of our knowledge, and even then the line on a soil map between two soil types is not to be regarded as a clear cut boundary, but rather as the approximate mid-point of the transition zone between two soil types. Such a zone may be one yard wide or 50 yards wide. This does not mean that our present systems of soil classification are not yet developed to the stage of giving valuable aid to the agriculturalist, but rather that present day soil classification is dynamic and that very careful study is required in assessing the significance of quantitative factors.

Fiji, in common with many other tropical regions, exhibits intense local variation in such important soil forming factors as

parent material (geology), water regime (precipitation, drainage, ground water, etc.), vegetations and organisms, topography and soil climate (which includes some of the above). While there are some regions of the world characterized by a relative constancy of soil formers which permit of good correlation between soil type and vegetation, soil type and geology and so on, most tropical regions are notoriously poor in this respect. In order to obtain true perspective we must examine our methods of approaching the problems of soil classification.

The only truly scientific approach is one which endeavours to treat the properties of a soil system as being functionally interrelated. Jenny[6] in his admirable text book, has fully recognised the usefulness of such an approach and undoubtedly, the functional analysis of soils will receive increasing attention during the latter half of this century.

The approach via functional analysis gives soil factors the status of independent variables that define the state of a soil system. Such a soil system is open and is distinct from purely logical systems. To define a soil system properties are stated and such properties (qualitative and quantitative) may be conveniently represented by symbols such as x^1, x^2, x^3, x^4, etc., where x^1 may represent parent material, x^2 climate, x^3 water regime and so on. Then:

$$F(x^1, x^2, x^3, x^4, \ldots .)=0 \qquad (1)$$

As Jenny[6] points out, such an equation is far too general to be of practical value to soil science and in fact, it is merely the definition of any natural body written in symbolic form. In expanding such an equation, it must be remembered that the magnitudes of the properties must not exceed or fall below certain characteristic values. For example, a soil containing more than 95 per cent water would be more a "swamp" or "river", than a soil.

Returning to equation (1), a change in any one of the x properties produces a different state or a different soil. We may represent this by the differential dx and consequently it follows that the number of soil states and soil types is infinite.

For half a century the existence of soil forming factors has been recognised but little has been done to expand the form of equation (1) and produce a fundamental equation of soil formation. Any soil system may be defined by reference to all five major forming factors—

1. Climate (Cl)—includes precipitation, temperature, etc.
2. Organisms (O)—includes micro-organisms, plants and higher animals.
3. Topography (To)—relief.
4. Parent Material (P)—geology.
5. Time (T)—maturity.

If we designate colour, pH, clay content, silica: alumina ratio and other values as x values, then:

$$x=f\ (Cl,O,To,P,T) \qquad (2)$$

where f stands for "function of" or "dependent on."

It is however, necessary to modify equation (2), as soil and environment are naturally interrelated. Thus, as emphasized by Jenny[6], the root hairs of a tree are in intimate contact with mineral particles and consequently must be treated as soil properties. The necessary modification is then:

$$x=f\ (Cl', O', To', P, T, \ldots) \qquad (3)$$

where symbols Cl., O., To., now refer to environment.

Equation (3) must, of course, be solved and this may be accomplished either—

(*a*) "in a theoretical manner, by logical deductions from certain premises," or

(*b*) "by either experimentation or field observation."[6]

The latter approach must be given preference at our present stage of knowledge and such approach must be backed by laboratory analysis of soil samples.

Considering the following set of equations of soil forming factors:

$x=f$ Cl' (Climate)
Cl', To', P, T, ...

$x=f$ O' (Organisms)
Cl', To', P, T, ...

$x=f$ To' (Topography)
Cl', O', P, T, ...

$x=f$ P (Parent material)
Cl', O', To', T, ...

$x=f$ T (Time)
Cl', O', To', P, ...

NOTE.—The subscripts indicate that the remaining factors do not vary.

It follows that the total change of any soil property is dependent on all the changes of the soil forming factors, or:

$$*dx = \left(\frac{\partial x}{\partial cl}\right) O',To',P,T\ dCl' + \left(\frac{\partial x}{\partial o'}\right) Cl',To',P,T\ dO' + \left(\frac{\partial x}{\partial To'}\right) Cl',O',P,T\ dTo' + \left(\frac{\partial x}{\partial P}\right) Cl',O'To,T\ dP + \left(\frac{\partial x}{\partial}\right) Cl',O',To,P\ dT \qquad (4)$$

The numerical magnitudes of the quotients in parentheses, are true indexes of the relative importance, of the various soil forming factors.

We now come to the most important point in our treatment. Any study of the soil in the field cannot avoid considerable variation in the magnitude of the variables. In the laboratory it is comparatively easy, for instance, to keep exact control of the conditioning variables (e.g. temperature, time, etc.) but under field conditions we know it is quite a different matter. Statistical treatment offers the only approach and such is justified, as equations possessing the character of general trends will lead the way to an accurate understanding of the principles of soil science.

In view of what has been said concerning variations in the magnitude of variables, it will be appreciated that satisfactory correlations between x properties are more likely in regions of uniform climate and topography such as deserts or great plains. In tropical regions of variable topography combined with wide variations in climate, organisms, and parent material, efforts to discover quantitative relationships among soil properties of the x type, must invariably lead to disappointment. As Jenny[6] states: "It is improbable that a function between two s properties† that possesses general validity will ever be found."

What then of our present systems of soil differentiation and classification based on x values (colour, texture, pH, exchangeable cations, etc.)? What of widely studied functions such as pH versus lime requirement, crop yields versus soil tests, etc.? If one were to collect and examine at random a large number of soil samples from all over the world and analyse for two x properties, no correlation between the two properties would be found. Only in areas of reasonable constancy of soil forming factors, would some limited correlation be found.

Bearing this in mind, we are now in a position to examine some of the problems of soil classification in Fiji.

*∂ Represents Greek delta.

†s here is the same as x.

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Visitors to Fiji have often expressed surprise at the rugged topography and intense dissection of the greater portion of the two main islands of the Group. Indeed, those who have had occasion to use some of the many native tracks removed from the main roads will appreciate that travel in Fiji is as difficult as anywhere in the world. In the "wet" zone (100–200 inches of rainfall per year), travel on foot at the rate of one mile per hour is by no means uncommon. Travel via the many watercourses is little better, as only the larger rivers have any extent of river flat at some distance from the river mouth. Steep ridges clothed in sub-tropical rain forest border most of the creeks and traverses at right angles to these creeks are very difficult.

Travel in the " dry " zone is not as difficult. The use of horses speeds progress but tracks must often be cut in the tall grass and reed country; for soil survey traverses do not necessarily coincide with established tracks.

In the course of present soil investigations in Fiji it has been found more convenient to concentrate on studies in the field during the months April to October and to undertake laboratory studies, during the months November to March, when rainfall, heat and humidity are at a maximum. Travel during the rainy season is both difficult and inconvenient and problems of transporting equipment are often insurmountable. Waterproof covers are required for many items and condensation or " sweating " inside the covers is a major difficulty. In view of the loss of time occasioned by adverse weather conditions (many tracks are impassable after four or five days of rainy weather) it is very doubtful if any field work should be undertaken during the rainy season.

From what has been said above, it will be appreciated that some of the classical methods of soil survey cannot be followed in Fiji. For example, to speak of a soil survey employing traverses at say two or four mile intervals across the two main islands, would be ludicrous in view of present facilities. This applies equally as well to a geological survey.

Quite apart from the difficulty of traversing large areas of Fiji, a major difficulty is encountered in the lack of accurate base maps and aerial photographic data. In any survey, whether it be land utilisation, geological or soil survey, the accuracy of basic data is of prime importance. An aerial photographic cover of the two main islands would enable time and expenditure on field work to be reduced by at least one-third and the value of such photographic data in other fields, has been stressed on several occasions.[1, 2]

In Fiji, with the exception of very small areas in the vicinity of Suva and Lautoka, aerial photographic data is non-existent. The position of accurate topographical and general maps, is little better. No accurate topographical data is available for at least 90 per cent of the total area of Fiji. The most accurate general maps are those on a scale of 16 chains to the inch prepared for the Native Lands Commission; most of the survey work being undertaken between the years 1930 to 1939. These maps supply data in connexion with Native Land and large areas of alienated land appear as blank spaces of the sheets. Accurate plans of individual leases are available but these are not suitable for soil survey work. The general position with regard to accurate base maps for soil or geological survey, must be regarded as most unsatisfactory.

Lack of accurate climatic and geological data constitutes another considerable handicap in soil classification in Fiji. Rainfall stations are not evenly distributed and appear to be confined to the more closely settled areas. There is a serious lack of data for high rainfall (130 inches) areas. Evaporimeter data is also lacking and such would be of particular value in soil science studies in the dry zone; as a consequence any evaluation of climatic factors, for example Küppen values, will be most difficult.

On the geological side interesting and important, but limited work, has been carried out by Woolnough[3], Ladd[4], Foye[5], White[6] and others. White's geological sketch map of Viti Levu is helpful in the field but the classification and groupings are very broad and tentative. The proposed plan for a geological survey of Fiji should provide valuable data for future soil science work in Fiji. It is not anticipated however, that data from this survey will be available before 1951 at the earliest.

The present programme of soil science research in Fiji has therefore been planned in the light of existing facilities with, it is hoped, some additional help from other quarters. During the 1948 season for field work, soil types and associations covering some nine hundred and sixty square miles of Viti Levu have been mapped, examined and sampled. In addition, over six hundred soil samples have been classified and despatched to headquarters for storage and subsequent chemical and physical examination. With present staff it will not be possible to complete all the chemical and physical examinations of these soil samples

before the commencement of field work in April 1949. Such involves some six thousand individual determinations and an estimated nine thousand man hours of highly skilled work; the greater portion of which can only be carried out by a qualified scientist. The appointment of additional scientific staff will enable laboratory studies to keep pace with field work and continue during the whole year.

Rather than consider here the detailed technical problems of soil classification which would be of limited interest, an attempt has been made to outline some points of general interest. It now remains to answer perhaps the two foremost questions framed in the minds of those who make their living from the soil or, who are concerned with problems of land classification and land-use planning. The two questions might very well be:—

(1) What will be the cost of the present soil science investigational programme, especially in relation to similar undertakings overseas ?

(2) In what manner will the information obtained be made available in so far as the peasant farmer (in the majority) and practical farmer are concerned ?

In reply to the first question it may be confidently stated that given adequate support, the present programme will cost as little as any comparable undertaking in the world. In terms of present acreages under food crops[7], the programme will cost less than 3½d. per acre. In view of present world prices, the value of this land would be well in excess of three and one half million pounds. This expenditure in terms of capital value is very small, particularly so, if the potential food producing acreage is considered. In this case the programme would cost less than 1½d. per acre for some 800,000 acres. The above figures do not take into consideration the value of the work in connexion with large areas of land suitable for silviculture. Although a strict comparison cannot be made, nevertheless, the social status of peoples is largely dependent on the soil and the above costs should be compared, for instance, with social services schemes in other countries, which range from £3 to £12 per head of population, based on the national income. Without land-use planning and efficient soil conservation it will be difficult to provide adequate food for future needs, or to improve materially the social welfare of native peoples, no matter how comprenhensive any such " social " schemes might be.

With regard to the second question, the results of present soil science investigations will be made available in the following manner. Upon completion of the programme the published report will contain the following information:—

(*a*) Detailed information concerning the chemical and physical status of the principal soil types.

(*b*) Present and potential uses of the particular soil types.

(*c*) Theoretical consideration in connexion with soil genesis; influence of soil forming factors (climate, geology, vegetation).

(*d*) Degree of erosion; erodability of soil type .

(*e*) A soil map of Fiji showing the extent and distribution of the principal soil types.

(*f*) An erosion map of Fiji showing the extent of present erosion and susceptability to future erosion.

(*g*) A potential land-use map.

(*h*) A present land-use map.

(*i*) A geological map compiled from all available information and information gained in the course of the present soil survey.

(*j*) Climatic maps compiled from all available information.

The mere publication of the above data is not enough. The people must play as intimate a part in the execution of the plan as those responsible for the data. The natural approach would be via extension services and education. With regard to the former, any extension officer with an appreciation of recent advances in methods of land classification for land-use planning, will experience little difficulty in the interpretation of the data. Simple agricultural education of the peasant farmer will be of great importance, together with an intensive programme of publicity and propaganda. Progress will be necessarily slow but each additional enlightened farmer will

serve as a " publicity agent " for his particular area. With a realistic approach to the problems involved and most important, the support of the people, the success of the programme will be assured.

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ENTOMOLOGY . . .

FLY BREEDING IN FIJI.

BY L. VERRIER.

It is well known that the ordinary domestic or other compost-heap has the disadvantage that if reglected, and the temperature drops, it is apt to become a fly-breeding horror; and this circumstance, has deterred many from constructing them

An experiment was recently carried out in Labasa to determine the extent to which fly-breeding would actually occur in the ecology of a small compost-heap in a domestic environment.

A compost was made in a bottomless box 2′ x 2′ square and 3′ high, and maintained at high tempertaure for five weeks. It was then deliberately neglected, allowed to cake on top, and insufficiently covered.

On the second day it was observed to be very attractive to house-flies, which could be seen alighting on the grass cover, and busily descending through this to the garbage below. Numberless larvæ were observed throughout the upper layers.

On the seventh night inspection at 10 p.m. showed the compost-box the centre of attraction to 56 specimens of *Bufo marinus* which had gathered round to pick off the migrating larvæ. None escaped during my watch.

No increase in the observed fly-population around the house could be detected during the experiment.

NEW SHIP TOFUA FOR SOUTH SEA SERVICE IN 1951.

The name Tofua is to be given to a new 5300 ton ship ordered for the Islands trade by the Union Steam Ship Company of New Zealand. The company has announced that an order has been placed with William Denny and Brothers, Ltd., Dumbarton, Scotland, for a twin screw vessel a little larger than the Matua. Delivery is scheduled for September, 1951.

A statement issued by the Union Company's head office at Wellington says that the decision to build has been made in response to the intention of the authorities in Samoa, Fiji and Rarotonga to increase production for export to New Zealand. When the new vessel is in service, direct discharge of Islands fruit at Lyttleton, as well as at Auckland and Wellington, should be practicable.

The new vessel will be powered by Sulzer diesel engines to give minimum speed of 15 knots.

The latest system of refrigeration for the carriage of fresh fruit cargoes will be installed in each of the five holds.

Modern accommodation will be provided for seventy-five passengers.

The name Tofua has been selected in repetition of a name well known in the trade and it is of interest to recall that Denny's were the builders of the previous Tofua.

Although the last previous order placed with them was for Hauraki, in 1922, Denny's have built forty vessels for the company.

ECONOMIC BOTANY . . .

THE BOTANICAL GARDENS, SUVA.

BY J. W. PARHAM.

I—Early Historical Associations 1820-1882.
II—Establishment and Development 1882-1918.
III—The present Collection of Trees and Shrubs.

EARLY HISTORICAL ASSOCIATIONS 1820–1882.

The Suva Botanical Gardens now occupy the site of the original Fijian town of Suva, whose former inhabitants moved across the bay about 1882. Wall(2) writing in 1919 states "Twenty-five years ago the moat and rampart were practically intact, but there are now no traces of them left, nothing now remains to tell the visitor that this was once a busy fortified town, nor that in 1843 when it was burned it was the scene of one of the fiercest and bloodiest fights in Fijian history."

Describing the old town the same authority writes: "Passing over the raised track across the moat, (opposite the lawn tennis pavilion) one entered the town; and right in front towered the temple of Ro Vono, situated on what it is now the east side of the present little ornamental water; and behind it, shaded by Nokonoko trees, was the mound sacred to Na Leka, the god of the dwarf denizens of the wilds. . . . To the old Fijians Suva, 'a little hill', was the mound on which the temple of Ro Vono stood and in which was concealed the sacred stone Vatu Bulia from Vatuwaqa, on which their chiefs were seated at their inauguration, and this mound gave the name to the town; but the name of Suva was never applied by them to any other place. The space near the clock tower was the burial place of the 'taukei' or land-owners—and in later days the gable end of the house of the Chief Tui Buia was almost on the beach road about half way between Cakobau Road and the gate entrance to Government House. The bure of Ratu Ravulo, who founded the town, was a little further in and close to it stood the house of Laca Levu, the high priest of the temple. Where the tennis courts now are, was the burial place of the chiefs—'nai usa ni maru'—where the fiercest fighting took place the day that Suva was burned."

"This town of Suva was founded not later than 1820 by the Chief Tabukaucoro who stripped the older hill towns of their inhabitants for the purpose. Tabukaucoro ranked as a powerful chief. As Tui Suva he could muster nearly a thousand warriors; he was also Vasu to Bau with all the privileges that went with that dignity and he had a strong alliance with all the hill tribes from Suva to Serua. Nevertheless, on the 6th April 1843 the town was attacked and burned by the Rewa people and many of its inhabitnats killed and eaten. In 1845, Cakobau began to take steps to rebuild Suva and to return its people to their own home; and the last time that the war drum was beaten in Suva summoning the warriors to the fray was towards the close of the Vugalei war about 1865 when, aided by an inroad of the Naitasiri clan on the people of Waimanu, they took and burned the towns of Lami and Tamavua and brought their inhabitants prisoners to Suva. As by this time the Kai Suva had become Christians, their ovens were heated only for feasts of turtle and dalo."

ESTABLISHMENT AND DEVELOPMENT 1882–1918.

The subsequent history of the site may be recorded briefly. In 1879, John Horne, Director of Forests and Botanic Gardens, Mauritius, visited the Colony at the request of Sir John Thurston, the Governor. He recommended, *inter alia*, the establishment of a Botanical Garden and Plant Introduction Station. This work was approved and by 1905 a large number of interesting exotic trees had been established as recorded by Knowles(1), Director of the Agricultural and Botanical Department who, in 1912, assumed control of the Gardens.

Space does not permit of a detailed account of the progress made, the dates of the planting of individual trees and of the

establishment of the amenities. As recorded on the bronze plaque at the Entrance Gates, the Gardens were reorganized in 1913, the then Governor, it is said, himself supervising the laying of threequarters of a mile of underground drains. The avenues of Royal Palms fronting the Cakobau and Suva Point Roads were planted with a spacing of twelve feet at this time. During the same year, records show that the following trees and shrubs were planted: 101 Royal palms, 39 Tree ferns, one each *Coffea liberica, C. arabica, C. robusta, Tecoma stans, Pimenta officinalis, Cinnamomum zeylanicum, Bixa orellana, Allamanda grandiflora, Agave sisalana, A. lindenii, Loquat, Mangosteen, Funtumia elastica, Livistona chinensis, Cocos plumosa; also* four *Latania borbonica,* three *Eugenia braziliensis* and two Traveller's Trees (*Ravenala*). The construction of a concrete clock tower and band stand, presented by Messrs. Henry Marks and Company Limited, was commenced towards the end of 1917. The tablet on the tower records the following information:—

> "Erected by Henry Marks and Company Limited in memory of their late Director, G. J. Marks, first Mayor of Suva who was drowned in the St. Lawrence River, Canada, through the sinking of the *Empress of Ireland,* 23rd May, 1914".

This memorial was opened by His Excellency Sir E. B. Sweet Escott, Governor of Fiji, on 7th June, 1918.

Unavoidably during the passing years the collections of trees have been reduced by losses due to winds and age but there are still some interesting and valuable specimens which are recorded in the present note. In 1947 the Department of Agriculture labelled the collection and planted the following additional species:—

Dawa (*Pometia pinnata*).
Coffee (*Coffea liberica*).
Tabebuia pentaphylla.
Yemane (*Gmelina arborea*).
Sago Palm (*Metroxylon vitiense*).
Mahogany (*Swietenia macrophylla*).
Tree Cucumber (*Arerrhoa bilimbi*).
Allspice (*Pimenta acris*).
Kapok (*Ceiba pentandra*).
Kavika (*Eugenia malaccensis*).
Coffee (*Coffea arabica*).
Rose Apple (*Eugenia Jambos*).
White Ixora (*Ixora odorata*).
Vesiwai (*Pongamia glabra*).
Golden Shower (*Cassia fistula*).
Tea (*Camellia sinensis*).
Vutuwai (*Barringtonia racemosa*).
Mahogany (*Swietenia mahogani*).
Soursop (*Annona muricata*)
Mango (*Mangifera indica*).
Vuleito Palm (*Veitchia storckii*).
Sausage Tree (*Kigelia pinnata*).
Vasa (*Cerbera manghas*).
Yellow Flamboyant (*Peltophorum inerme*).
Pride of India (*Lagerstroemia flos-reginæ*).
Persian Lilac (*Melia azedarach*).
Rubber Tree (*Hevea brasiliensis*).
Cocoa (*Theobroma cacao*).
Cashew Nut (*Anacardium occidentale*).
Balsa (*Ochroma lagopus*).
Hydnocarpus wightianus.

THE PRESENT COLLECTION OF TREES AND SHRUBS.

ORNAMENTAL AND TIMBER TREES LEGUMINOSÆ.

1. *Albizzia procera,* Silver-bark Rain tree (Fig. 1).—This is represented by a large specimen growing near the centre of the grounds. Its fine feathery foliage and large clean bole and branches attract the attention of most visitors to the Garden. The flowers are creamy yellow, to white, abundantly produced in clusters at the branch ends—and are followed by numerous flat red brown pods about 4–6 inches long. The timber is useful. The species is naturalized in various parts of the Colony and grows well in the dry zone.

2. *Albizzia lebbek,* Siris or Rain tree.—A large broad-topped tree, fast growing with spreading limbs (30 ft. H). The leaves are pinnate and about 10 inches long. The pods are conspicuous when the foliage is shed. These pods are straw-coloured, leathery, flat, thin and shiny and are about 5 to 8 inches long. In full blossom between September and October. The wood seasons, works and polishes well and

is fairly durable. It is used in India for furniture, sugar-cane crushers, oil-mills, canoes, house-posts, building and fuel.

3. *Andira inermis.*—A native of Tropical America and Western Tropical Africa. Used for windbreaks in the West Indies.

4. *Bauhinia purpurea* Butterfly tree.—A native of India and China. This tree flowers over a long period from about July onwards. Very showy large flowers of a pink shade merging into purple.

5. *Brownea coccinea.* Flowers September to November.—A short spreading tree, native of Tropical America. The flowers are in large scarlet clusters, produced in large numbers along the stem and older branches.

6. *Caesalpinia coriaria* Dividivi or American Sumach.—A native of dry tropical America. A spreading medium-sized tree with fine feathery leaves, producing greenish-white strongly scented flowers, 25–30 feet high with small bipinnate leaves. Tree adapted to a dry climate and grows up to about 2000 feet. The pods are rich in tannin.

7. *Cassia fistula* Golden Shower or Indian Laburnum.—A native of tropical Asia. The bark is used for tanning and the pulp of the fruits is used as a mild laxative. Leaves ovate in 4–8 pairs. The pod is smooth and cylindrical. Now growing to 40 or 50 feet high. The flowers are bright yellow and slightly fragrant. The heart wood is extremely hard and is used for posts.

8. *Cassia grandis* Pink Shower or Horse Cassia.—Introduced from Panama. Flowers in October for a short period. Leaflets 8–20 pairs, oblong and rounded at both ends with sparse minute hairs on the upper surface, pubescent—tomentose beneath. The pod is compressed cylindrical and rough with transverse marking. one margin with a prominent obtuse rib, the other with two prominent ribs. The wood is strong and handsome and used for many purposes.

9. *Cassia nodosa* Pink and White Shower.—A native of India and the Malay Archipelago. It flowers from late October through to December. A moderate sized upright tree, very beautiful when flowering in profusion, its bright pink and rose scented flowers in large sprays. The flowers are followed by cylindrical pods 12–15" long. Tree is deciduous for a short period in dry weather.

10. *Colvillea racemosa.* Introduced from Mauritius.—A beautiful tree with large bipinnate feathery leaves with twenty or more pairs of primary leaflets each divided into as many as twenty-eight pairs of secondary leaflets. The flowers are borne in long, loose racemes, coloured a bright scarlet with showy yellow stamens It flowers from February to March. A medium sized tree 50–60 feet high. Presents a very showy appearance when flowering.

11. *Delonix regia* Flamboyante.—Introduced from Madagascar. The Flamboyante begins flowering early in October and continues over a period of several months. A beautiful tree when in full blossom bearing immense sprays of scarlet or orange flowers. The tree grows to a height of 50 to 60 feet with spreading habit and has very long handsome, fine, feathery, bipinnate leaves. Almost deciduous for a short time in dry season.

12. *Derris dalbergioides* Introduced from Malaya.—A tall erect tree with fine feathery foliage. Deciduous for a brief period after which it bears at the ends of the branches masses of purplish pink blossom, rendering the tree a striking object. It does not blossom for long, however.

13. *Dipteryx odorata* Tonka Bean.—A native of tropical South America and Trinidad. A large tree bearing a scented bean which is used for snuff and perfumery. The fragrant seeds are used for flavouring. Sometimes used by pastrycooks and confectioners as a substitute for vanilla. A large tree with pinnate leaves. The fruit is a small oblong fibrous pod containing one almond-shaped black or brownish seed. The seeds are subjected to a crystallization process, being soaked in rum for 24 hours and slowly dried when they become covered by a white crystalline substance (coumarin).

14. *Inocarpus edulis* Ivi or Tahitian Chestnut.—A native of the Pacific Islands. A moderate-sized tree with large shiny

leaves, indigenous to the Pacific Isles where the large fleshy seeds (one or two in each stout pod) form an article of food with the natives. The unripe seeds boiled and roasted are considered palatable.

15. *Ormosia dasycarpa.*—Seeds medium-sized hard, bright scarlet, blotched with black and brown. Very popular for buttons, necklaces and ornaments. A moderate-sized tree of Tropical America.

16. *Peltophorum inerme* Golden Flamboyante.—A native of South-East Asia. The Golden Flamboyante is a fast growing tree with foliage similar to that of the Flamboyante (*Delonix regia*), but the young shoots are rust coloured. The leaves are bipinnate with 16 to 20 oblong leaflets each about half an inch long. The showy, scented flowers are borne in large panicles and are rusty yellow or gold in colour.

17. *Pithecellobium saman* Rain tree or Saman.—A native of Central America and the West Indies. A very large spreading quick-growing tree commonly planted in tropical countries as a shade tree. It has a rather shallow root system, grows rapidly, being top-heavy and loosing its upright symmetrical habit. The brown rather flat pods are about 6–8 inches long and cover a quantity of sweet sugary pulp and are relished by cattle. The small pinnate leaves which form a canopy of shade in the day-time, close up at night.

18. *Tamarindus indicus* Tamarind.—A native of Tropical Africa and India. The Tamarind is an excellent shade tree grown chiefly for its fruits which in India are largely used for curries, chutney and sherbets. The wood is very hard and in India is often used for cane mills and oil mills. The fruits remain over a long period. Grows to a height between 30 and 40 feet. The diameter of the trunk is often five feet or more. Leaflets in 8–20 pairs, oblong, apex rounded, base unequal-sided. Flowers of white or pale yellow with red veins.

19. *Intsia bujuga* Vesi.—A native of Fiji. Hardwood.

20. *Adenanthera pavonina* Red bead tree or Red Sandalwood.—A native of Africa and South Asia. A moderate-sized evergreen, quick-growing, upright tree with small, feathery pinnate foliage. The flowers are cream in colour and the pods are six to eight inches long. These pods curl up as they mature and expose the hard brilliant red seeds which are commonly used as beads. Flowers from October to December.

Fig. 1.
Silver bark Raintree, (*Albizzia procera*), near the centre of the grounds.

THE PALMS.

Palmæ.

1. *Actinophloeus macarthurii* Cluster Palm (Fig 2).—Introduced from Australia. An attractive slender-trunked species reaching a height of 25–30 feet. The pinnate leaves are dark green with leaflets obliquely cut at the ends as if bitten off. The palm usually grows in clumps with several stems surrounded by many suckers. The Cluster Palm flowers frequently but is at its best between September and November when masses of bright red berries are produced.

2. *Caryota mitis* Lesser Fish-Tail Palm.—A native of South-East Asia. The trees of this species are small and do not attain a height of more than 25 feet. The plant suckers freely giving rise to several smooth, slender stems.

Fig. 2.
Cluster Palm, (*Actinophloeus macarthurii*), **surrounded by epihytic ferns at the base.**

3. *Chrysalidocarpus lutescens* Golden Cane Palm. (Fig 3).—Introduced from Madagascar. A low growing palm having many slim yellow-ringed trunks which grow into a clump of great beauty. The Golden Cane Palm is prized as an indoor ornamental and is well adapted to pot culture.

4. *Cocos nucifera* Coconut.—Grows abundantly throughout the Tropics. Very well known. A tall stately palm 70–80 feet high with a stout wavy stem surrounded by a crown of long arching handsome pinnate leaves. It is the most important of palms, furnishing the inhabitants of the tropics with practically every requisite including food, sugar, drink, medicine, toddy, fibre, timber, thatch. Though cultivated in most tropical countries, in some extensively (for copra), it is nowhere found in a wild state. Its cultivation and the preparation of its different products for local use or for export form an important industry in many Pacific Islands.

5. *Dictyosperma album* A native of Mauritius.—This palm grows to a height of about 30 feet. The slender trunk, which is marked with rings, has a bulge at the base. The light green leaves are pinnate and about ten feet long.

6. *Elœis guineensis* Oil Palm.—A native of Tropical Africa. This palm furnishes two kinds of oil, one from the pericarp, known as "Palm Oil", and the other from the kernel. A stately, erect, handsome palm 60–70 feet high with a stout stem and large pinnate leaves. The palm furnishes the natives with many of their needs in Africa. The palm is moneocious, i.e. bears both male and female flowers on the same tree but on separate branches. The flowers are fertilized by wind or insect.

Fig. 3.
Golden cane Palm, (*Chrysalidocarpus lutescens*).

7. *Latania borbonica* from Mauritius.—A fan-leaved palm with a heavy bloom on the leaves which are quite large and leathery. Slow-growing and attractive.

8. *Livistona australis* Australian Fan Palm.—A native of Australia. The Australian Fan Palm grows up to 80 feet high and has a slender stem which is reddish-brown in colour and is marked with the rings of fallen leaf scars. The petiole is spiny on the margins, and the blade is orbicular from three to six feet in diameter. The fruits are globular. The leaves are in a dense crown, the flowers small and numerous in spikes at the end of the branched clusters and the fruit round, six to nine inches in diameter, seeds globular, and dark coloured. The wood or outer part of the stem is fairly hard, of a dark colour and prettily marked. It is used by the Australian aborigines for making spear-heads. This palm is tropical and sub-tropical in habitat.

9. *Livistona chinensis* Chinese Fan Palm.—Introduced from China. This palm has a stout stem and grows to a height of about 30 feet. The fruits are olive-shaped, about five-eights of an inch long and a dull bluish-green in colour. The seed is oblong.

10. *Oreodoxa oleracea* Cabbage Palm. (Fig 4).—Introduced from the West Indies. The Cabbage Palm is very tall, often reaching a height of a hundred feet or more. The stem is more uniformly cylindrical throughout than that of the Royal Palm. A very stately palm growing to a height of 80–100 feet which looks very effective in avenues.

11. *Oreodoxa regia* Royal Palm.—A native of Florida, U.S.A. An erect growing palm which attains a maximum height of between 90 and 100 feet. The trunk is massive, sometimes three to four feet in diameter, light grey, smooth, slightly bulged or swollen about midway and at the base. The crown of large deep-green pinnate leaves, up to 12 feet in length, with numerous leaflets two to three feet long, makes this one of the most ornamental and striking trees.

Fig. 4.
Cabbage Palm, (*Oreodoxa oleracea*), The finest specimen in Fiji.

12. *Pelagodoxa henryana* Marquesas Palm (Fig 5).—This very rare species is apparently indigenous to the Marquesas where only a small number of trees were found in the type locality, a side ravine at the head of Taipi Vai. There are three specimens in the Botanical Gardens. This palm is generally small in size—up to 20 feet high. The leaves are unusual, the blade entire when young but soon shredded by the wind into many irregular divisions. The fruits are conspicuous, borne in a panicle, globose, often over two inches in diameter. The pericarp is thick, corky-fibrous and irregularly split into coarse pyramidal projections on the outer surface, with a large solitary, hard seed.

13. *Phoenix canariensis* Canary Date Palm (Fig 6).—Introduced from the Canary Islands. This palm has a spread of 30 feet and is tall growing with graceful, pinnate leaves. It has a massive trunk.

Fig. 5.

Marquesas Palm, (*Pelagodoxa henryana*), **The rarest plant in the Gardens.**

14. *Phoenix dactylifera* Date Palm.—A native of North Africa, Arabia to Northern India. The date from this palm is of great use commercially. Attains a height of 60–80 feet with handsome pinnate leaves. All parts of the palm serve many domestic purposes. The palm is of a hardy nature thriving where other plants will barely exist. Grows best in a dry atmosphere, deep alluvial clayey soil and plenty of water during its fruiting and flowering season.

15. *Phoenix sylvestris* Indian Date Palm or Wild Date Palm.—A native of India. This is a tall vigorous-growing palm which is very symmetrical and attractive. The inflorescences are in conspicuous orange-coloured panicles. The fruits are small and oblong. Stiff pinnate leaves. It is cultivated in India for the production of sugar.

16. *Pritchardia pacifica* Fiji Fan Palm.—One of the most graceful and handsome of the fan-leaved palms. The trunk is erect and smooth and up to 30 feet high. The leaves are about three or four feet long with spineless leaf-stalks about three feet in length. The fruits are half an inch in diameter. Called Masei or Aivui and leaves used by Fijians as a fan or umbrella.

Fig. 6.

Canary Island Palm, (*Phoenix canariensis*), **with the Fijian fern,** (*Davallia feejeensis*) **growing on the base. Memorial Clock Tower in back ground.**

17. *Cycas Rumphii* var. *Seemannii* (Cycadaceæ) Fern-Leaf Palm or Logo-Logo. (Fig 7).—A native of Fiji. A large robust plant, the Suva specimen is obviously of great age. The fruit was formerly used by the Fijians during famines to make a kind of bread.

Fig. 7.
Fijian Cycad or Logologo, (*Cycas rumphii* var. *seemanni*).

THE TREES AND SHRUBS.

THE PINE FAMILY.

Pinaceæ.

1. *Agathis vitiensis* Fiji Kauri or Dakua (Fig 8).—Yields valuable timber and kauri gum from which oil and turpentine can be extracted. One of the largest of the forest-trees now found only in upland forests of the interior. Fruits from June onwards.

2. *Araucaria bidwillii* Bunya Bunya Pine. —Introduced from Australia. A large symmetrical tree with evenly dome-shaped crown and whorled branches, lanceolate leaves alternate without stalks and in crowded spikes about one and a half inches long. The fruit cones are 9–12 inches by 7–8 inches in diameter and the egg-shaped seeds two inches (or more) long by about one inch broad. It reaches 100 to 150 feet in height, the unbranched cylindrical stem sometimes being 80 feet. The very rough bark often measures up to six inches in thickness and is dark brown or almost black. The seeds are much valued as food by the Australian aborigines. The wood of the Bunya Bunya pine is very strong, almost white, even-grained, with many beautiful veins, polishes well and works very easily and is useful for indoor work. The tree has a pure and clear resin, bright red in colour, quite brittle and powders readily. It flows from every slight wound; is quite hard and has a pleasant odour.

3. *Araucaria cunninghamii* Hoop Pine.—Found in Queensland and New Guinea. Possesses a timber of great commercial importance, strong and durable when dry, but decays when exposed to alternate damp and dryness. It is fine-grained and polishes well. Hoop Pine is a giant conifer, very tall, up to 150 feet and often five feet in diameter, and of quick though erratic growth, the unbranched stem sometimes 90 feet high. It has a conical crown which becomes flat-topped with age, it carries rather scanty foliage, the leaves triangular in shape, very narrow and curved, crowded on the branches without stalks. The fruit

Fig. 8.
Fijian Kauri or Dakua, (*Agathis vitienssi*).

cones are ovoid, three to four inches long. The trunk is very dark brown or nearly black, marked by transverse wrinkles and fissures, having the appearance of horizontal bands like hoops, and it is rough and hard.

4. *Araucaria excelsa* Norfolk Island Pine (Fig 9).—A native of Norfolk Island. A fine symmetrical tree with whorled branching. A handsome evergreen tree. Short, horizontal spreading branches. Attains a great height. Commonly grown in temperate countries as an ornamental pot-plant, it thrives at medium and high elevations in the tropics.

Acanthaceæ.

5. *Eranthemum nervosum.*—Originally growing in Tropical Asia but is now common in gardens everywhere. Shrub with ornamental many-coloured leaves.

Fig. 9.
Norfolk Island Pine, (*Araucaria excelsa*).

ANACARDIACEAC.

6. *Harpephyllum caffrum* Kaffir Plum.—Origin—South Africa. At all ornamental tree with thick, shining foliage. The pinnate leaves usually have 11 leaflets and are about 12 inches long. The fruits are borne in clusters on long stems and resemble the fruit of a large olive in shape and size.

6. *Mangifera indica* Mango.— Origin India. A medium or large sized, spreading and quick-growing tree. It bears large panicles of greenish-white, scented flowers followed two and a half months later by the fruit. The round, oblong or ovoid fruit is somewhat flattened, generally with a fairly pronounced beak near the apex. The fruit weighs from 6½ ozs. to 1½ lbs. and has a rather tough thin skin and when ripe is yellow, reddish or green. The flesh is usually of a reddish tint with a distinct, pleasant, aromatic flavour. In the centre is the large, ovoid, fibrous, flat seed. The tree is cultivated in all warm countries and the fruit is used largely in chutneys, jam and preserves. Flowers in September and October and fruits in January and February.

7. *Pistachia chinensis* Chinese Pistache.—Introduced from China. A round topped tree with a short main trunk and heavy branches. The leaves are odd-pinnate with 11–13 ovate-lanceolate leaflets. The fruits are red when ripe and are resinous.

8. *Spondias cytherea*, Wi or Otaheite Apple.—A tall tree with large pinnate leaves. It is deciduous for a short period in July. The fruits are yellow and up to three inches long, ovoid in shape and fairly sweet in flavour. The fruit is used widely as fresh fruit or for making preserves. The tree flowers from December to January and fruits from February to March.

THE DOGBANE FAMILY.

Apocynaceæ.

9. *Plumeria acutifolia* Frangi pani or Temple Tree.—A low spreading semi-succulent milky tree or large shrub originally introduced from Tropical America. The tree is almost quite bare of leaves in the dry season when it bears large heads of white (with yellow centre) and highly fragrant flowers followed occasionally by a few bifurcated pods. Easily grown from cuttings. *Plumeria rubra* is a tree similar to *P. acutifolia*, having bright pink flowers in profusion. It is very showy and continues flowering for several months. Flowers between September and February.

THE ARALIA FAMILY.

Araliaceæ.

10. *Brassaia actinophylla* Queensland Umbrella Tree.—A handsome glabrous tree 30 to 40 feet high. It derives its popular name from the fact that its large oblong leaves, six inches to a foot long, are set like umbrella ribs at the top of numerous stems. It has a dense head of small red honey-laden flowers, much favoured by birds, and its wood is dark, soft and close-grained but not durable. The genus is limited to a single species, endemic to Australia. Flowers from December to March.

11. *Polyscias fruticosa* Introduced from the Malay Archipelago.—A shrub widely cultivated as a hedge and ornamental in tropical countries.

THE BIGNONIA FAMILY.

Bignoniaceæ.

12. *Crescentia cujete* Gourd Tree or Calabash Tree (Fig 10).—A small medium-sized tree with a low crown and wide spreading horizontal to drooping branches. The flowers develop from buds of the older wood of the trunk and branches and are usually solitary, dark purplish in colour and two to three inches long. The heavy, hard, gourd-like fruits may grow to 12 inches or more in diameter—the shells are used as cups or basins. Flowers in August and September.

13. *Jacaranda rhombifolia* Origin: Northern South America, Venezuela and Guiana. —A large spreading tree, 40–50 feet high with delicate fern-like foliage and a profusion of lavender-blue flowers. Flowers September to November.

14. *Spathodea campanulata* African Tulip or Fountain Tree.—Origin: Western Tropical Africa, now widely cultivated in the tropics. A tall erect-growing evergreen tree, usually 60–70 feet high when fully grown. The bright orange-scarlet flowers are large and showy, produced freely in short terminal racemes. The broadly winged seeds are borne in long flattened capsules. The African Tulip has a long flowering season but is at its best from October through to March.

15. *Tecoma stans.*—Originally from Central America but now commonly cultivated throughout the tropics. Small tree or shrub with bright yellow bell-shaped flowers.

16. *Tabebuia serratifolia.*—Origin: Tropical South America, Trinidad. A small tree with 5-foliate leaves and having masses of bright yellow bell-shaped flowers. Introduced by Professor Paterson in 1945 from Trinidad.

Fig. 10.

Gourd Tree, (*Crescentia cujete*), with a variety of the Coconut (*Cocos nucifera*) on the right.

Burseraceæ.

17. *Canarium commune* Java Almond.—Origin: Malay Archipelago and the Pacific. A large handsome tree with small pinnate leaves characterised by a remarkable buttressed trunk or laterally compressed surface roots, the latter develop into enormous erect flanges of nearly uniform thickness so that solid circular sections may sometimes be cut out from them to form ready-made cart wheels. The tree is much cultivated for shade and ornamental purposes.

It bears in great abundance large pendulous clusters of fruit of the size of small plums, dark purple when ripe. The kernel is edible, resembling sweet almonds. Thrives in hot and moist areas.

Combretaceæ.

18. *Terminalia arjuna* Arjan.—From India. A very large spreading tree with heavy branches and oblong, leathery leaves. The flowers are inconspicuous and the fruits are about one inch long and are winged. In Central India it is often used for shade along the roadside.

Elæocarpaceæ.

19. *Elæocarpus grandis* White Quondong.—A large Australian tree supported by high-flanged buttresses and radiating limbs carrying a canopy of dark-green, lance-shaped tooth-edged leaves, six inches long. Fruit a drupe with a skin of saxe-blue colour containg a large sculptured stone or seed with the appearance of a carved bead. The wood is light and the timber useful for various purposes.

Guttiferæ.

20. *Calophyllum inophyllum* Dilo or Alexandrian Laurel.—Common in the tropics. An evergreen tree widely distributed throughout the tropics. Locally this is a common coastal tree. The oil from the nuts is used medicinally and the timber is used widely in boat building. The flowers are small, white and fragrant. The fruits are round and nearly an inch in diameter. The Dilo flowers in September.

Euphorbiaceæ.

21. *Hevea brasiliensis* Para Rubber.—Origin: Amazon region of Brazil. A quick growing, tall, erect tree from which rubber is tapped when the tree is five or six years old. It flourishes in any moderately good deep soil provided the rainfall is not under 80 inches a year. The seeds are large, roundish, and mottled or blotched.

Lauraceæ.

22. *Cinnamomum camphora* (Camphor).—Common in Japan, Formosa and China. The camphor industry received a severe blow on account of the synthetic production of camphor from turpentine. Only certain trees will give crystalline camphor. A large, spreading, round-headed tree reaching a height of fifty feet or more. The camphor tree flowers between September and October.

23. *Cinnamomum zeylanicum* (Cinnamon).—Originally grown in Southern India, Ceylon and Malaya. The bark of this tree furnishes the cinnamon of commerce. A moderate sized or large tree, 40–60 feet high with 3–5 nerved alternate leaves. Cinnamon was one of the earliest known of the spices. The cultivated tree is grown as a bush in Ceylon. Flowers from September to November.

Lecythidaceæ.

2—4. *Barringtonia speciosa.*—A medium sized handsome spreading tree with large shining leaves, producing large white, fugacious flowers, consisting chiefly of a bunch of numerous long white stamens. The large quadrangular, one-seeded fruit, with its thick fibrous covering is a good example of floating fruits being commonly found in lagoons and rivers. The tree is indigenous to the sea-coast of Ceylon and is often planted for ornament. Flowers from early October to November. Native name, Vuturakaraka, seeds used for poisoning fish.

25. *Couroupita guianensis* Cannonball Tree (Fig. 11).—A native of tropical South America, introduced from Guiana. A large erect tree. The flowers are borne on heavy woody racemes several feet in length which are attached to the trunk or larger branches. The flowers are large and of an unusual shape, fleshy, reddish-yellow on the outside and crimson on the inside. Huge brown hard globular fruits filled with evil-smelling pulp are borne in numbers. The tree is not common locally. The Cannonball Tree flowers from September to October. A remarkably striking tree.

Loranthaceæ.

26. *Loranthus insularum.*—The Fiji Mistletoe, with bright red and yellow flowers, is a conspicuous parasite on the camphor tree. The seed is carried by birds and the young plants establish readily on oleander, Ivi, and many other host shrubs and trees.

Lythraceæ.

27. *Lawsonia inermis* Henna or Mignonette Bush.—Originally from Tropical Asia and East Africa. An ornamental shrub now introduced to most tropical countries which grows to a height of 6–8 feet. Often cultivated in hedges as a dye plant. The small oval leaves are often used in cosmetics. It flowers between October and December.

Fig. 11.

Cannonball Tree, (*Couroupita guianensis*), **with a Royal Palm** (*Oreodoxa regia*) **to the left.**

28. *Lagerstroemia indica* Christmas Bush or Crepe Myrtle.—A native of Japan, China, the Moluccas and North-East Australia. Introduced in the gardens of all tropical and sub-tropical parts of both hemispheres. Specially suited to the sea coast. Flowers from November to January—large magenta sprays. There are pink and white varieties.

Malvaceæ.

29. *Hibiscus rosa-sinensis* Hibiscus or Rose of China.—Origin East Asia. There are numerous varieties or crosses. Large single or double flowers of different shades, many very showy. Propagated by cuttings. A tall shrub. The flowers give a red dye commonly used in Ceylon for colouring in cookery.

Meliaceæ.

30. *Cedrela odorata* Cedar or Toon Tree.—A medium sized tree with large deciduous leaves of 11–7 oval lance-shaped membranous leaflets three to five inches long—aromatic bark. Woody capsules. Resembles the Fijian tree Vesida (*Dysoxylum* sp.). Timber useful.

31. *Melia azedarach* China Berry or Persian Lilac.—Origin East Asia. A medium sized tree which prefers a dry climate. The leaves are deciduous 2–3 pinnate. The lilac flowers are borne in large showy panicles and the fruits are smooth yellow drupes ½ to ¾ inch in diameter. The seeds are often used as beads. Flowers from September to November but is at its best in early October.

32. *Swietenia macrophylla* Large-leaved Mahogany.—A handsome upright tree of Tropical America, distinguished from Mahogany by its larger leaves and its more rapid growth. It thrives in a dry or moist climate up to 2,000 feet. It is the source of Honduras and Mexican mahogany.

33. *Swietenia mahogani* Mahogany.—The mahogany tree long noted for its superior wood is a native of Tropical America. It is a useful shade and ornamental tree, being evergreen, upright, 60–70 feet high, with small pinnate leaves. It is best suited to a rather dry climate. Is rather a slow grower.

Moraceæ.

34. *Artocarpus communis* Breadfruit or Uto.—Common in Polynesia. Many varieties of this useful tree occur in Fiji. The leaves are characteristic: with large pinnatifid or pinnatisect blades, rough to the touch. Fruits globular often six inches or more in diameter. Fruits from August onwards for several months. A valuable food plant in the Pacific.

35. *Artocarpus integrifolia* Jack or Jak Tree or Uto ni Idia.—Origin India and Malayan Region. A large tree of up to 60 feet high, erect growing with a spreading crown. The leaves are firm and leathery,

deep green, elliptic to obovate, blunt and apex five to eight inches long. The immense fruits weighing as much as forty pounds are borne only on the trunk or larger limbs. They are roughly oblong or oval in shape up to two feet long and covered with rough projections or knobs. The seeds are edible and are often roasted and served in curry. When ripe the fruit usually has an overpowering odour but the creamy coloured or yellowish, soft flaky pulp is eaten either raw, boiled or fried and is used as a vegetable for curries. The tree affords an excellent timber, lemon yellow at first, it turns with age to a very dark red like mahogany to which it is only a little inferior.

Musaceæ.

36. *Ravenala madagascariensis* Traveller's Palm (Fig. 12).—A native of Madagascar. The Traveller's Palm attains a height of 30 feet and its shape is that of a huge open fan. The leaves are often 15 feet long and the leaf-stalks store a watery fluid. The seeds are black with a bright blue aril. It flowers over a long period. It requires a hot humid climate. The large hollow sheathing leaf-stalks form receptacles in which considerable quantities of secreted water are stored, hence the popular name. Propagated by suckers or seed.

Myrtaceæ.

37. *Eugenia jambolana* Jambolan or Java Plum.—Introduced from South East Asia and the East Indies. A large tree commonly grown about Indian homes. The fruit is small, oblong and a deep reddish colour. The seed is used for making preserves. There are several varieties, some of which bear larger and more juicy fruit than others.

38. *Eugenia sp.*—A shrub, six feet high with large oblong glossy green leaves and conspicuous red juicy fruits, 6–9 inches in length. The origin of this plant is not recorded.

39. *Eugenia micheli*. Surinam Cherry or Pitanga.—A native of Brazil. An ornamental shrub or small tree commonly grown in Suva gardens and naturalized as a garden escape. The foliage is evergreen, glossy, and reddish-green in colour. The ribbed fruits, pendent on slender stems, are about one inch in diameter and very ornamental. These are eaten as a fresh fruit and used in making jelly. Flowers in October and November, followed by large numbers of bright red fruit.

40. *Pimenta acris.* Bay Tree.—From West Indies and Tropical South America. Bay oil, from which Bay Rum is made, is an essentail oil obtained by the distillation of the leaves of this tree. It flowers from September to November. A small erect tree. Oil used as a perfume for shaving soaps and in the hair wash known as "Bay Rum".

Fig. 12.

Traveller's Tree, (*Ravenala madagascariensis*), **famous for the reservoir of water in the leaf petioles.**

Oxalidaceæ.

41. *Averrhoa bilimbi* Bilimbi or Tree Cucumber.—A native of Moluccas. A small tree 25–30 feet high, of symmetrical habit. The leaves are odd-pinnate with five to nine leaflets which increase in size towards

the leaf tip and are from one to two inches long. The unique fruit is a translucent yellow colour and about two inches long. The Bilimbi flowers in September. A small fine-foliaged tree. Fruit resembles a small green cucumber. It is produced in clusters on the trunk and oldest branches and esteemed in pickles and preserves.

Piperaceæ.

42. *Piper aduncum* Locally called *Yaqona ni Onolulu*, i.e. Honolulu Pepper. Originally from the East Indies and Java. A shrub or small tree which has become naturalized and now may be seen in many places as a weed. The plant is easily recognized by the knotted stem and branches, the pale green leaves and the curved white flowered spikes or catkins which are solitary and curved back on the upper side of the branches. Flowers all the year round.

Punicaceæ.

43. *Punica granatum* Pomegranate.—From Eastern Mediterranean countries and South-West Asia. The pomegranate is cultivated and grows wild throughout the tropics and sub-tropics. A shrubby tree which grows to a height from 15 to 20 feet. It is semi-deciduous with shiny green leaves which are two and a half inches long. The large blossoms are a deep orange-red in colour and the bright red and yellow fruit are two to four inches in diameter. The colour of the blossoms and the fruits of this tree make it a striking ornamental which is found growing in many Suva gardens. Flowers over a long period but is conspicuous from September onwards.

Rhamnaceæ.

44. *Zizyphus jujube* Chinese Date or Jujube Tree.—Grown in tropical and sub-tropical Africa and Asia. An ornamental tree which reaches a height from 25 to 30 feet. It is armed with sharp slender spines and the leaves are from one to three inches long and prominently three-nerved from the base. The fruits are from one to two inches long with a single hard seed and deep brown when ripe. The fruits are eaten fresh, dried, candied and preserved.

Rosaceæ.

45. *Chrysobalanus icaco* Coco Plum.—From tropical South America and West Indies. A large straggling shrub or small tree. Bears round reddish-purple, plum-like fruits at the end of the branches, each fruit having a large kernel covered with white soft sweetish but scanty pulp.

46. *Photinia japonica* Loquat.—A native of China and Japan. An edible fruit grown in the sub-tropics and cooler parts of the tropics. The loquat does not bear fruit in Fiji. A medium sized evergreen and symmetrical tree with large handsome serrate leaves which are woolly white underneath. The fruits are yellow, small and pear shaped. The dingy white flowers are delightfully fragrant.

Rubiaceæ.

47. *Coffea arabica* Arabian Coffe.—Introduced from Africa. It is a small tree, native of Abyssinia, which has been introduced into most tropical countries. Most of the world's coffee comes from this tree. The first crop of coffee beans, a small one, may be harvested when the tree is three years old. Grows well in Fiji. Flowers from September onwards.

48. *Ixora macrothyrsa* Red Ixora.—Flowers a deep red in large clusters and very showy. From Ceylon and India. A popular shrub because of its masses of flowers and handsome appearance.

49. *Ixora lutea* Yellow Ixora.—From Ceylon and India. Bright orange-yellow flowers.

50. *Ixora coccinea* Scarlet Ixora.—Introduced from the East Indies. An evergreen shrub with scarlet flowers.

51. *Ixora odorata* Pink Ixora.—Flowers long, tubular, in large heads, white and pink. Native of Madagascar.

Rutaceæ.

52. *Citrus sinensis* Sweet Orange.—Introduced from China. Flowers in October and November. The fruit matures in April.

Sapindaceæ.

53. *Litchi chinensis* Litchi.—From China. An evergreen tree with a low, spreading crown and a heavy trunk. The foliage is

a deep, glossy green with leaves from five to eight inches long and abruptly pinnate with five to seven leaflets. The Litchi does not fruit in Fiji where it is quite rare.

54. *Pometia pinnata* Native name *Dawa.*—A large tree with buttressed trunk and large pinnate leaves often 2–3 feet long—leaflets large serrate—young shoots bright red. During February this tree bears a drupaceous fruit with edible gelatinous pulp—similar to the *litchi*. Timber useful for veneers.

Sapotaceæ.

55. *Chrysophyllum cainito* Star Apple.—Grown originally in the American Tropics. An ornamental fruit tree which grows to a height of between 25 and 30 feet. The deep green leaves are oval to oblong and about three to five inches long. These striking leaves are glabrous above and covered with a lustrous coating of golden-brown and coppery pubescence beneath. The fruit is globular, two to four inches in diameter, smooth, green and purplish in colour with a soft white pulp which is quite sweet when ripe.

56. *Mammea americana* Mammey Apple.—Native of the West Indies. A tree, 50 to 60 feet high, with heavy branches and a dense crown of foliage. The leaves are deep, shining green, leathery and oblong. They are obovate and four to eight inches long. The fruit is nearly spherical, 3–5 inches in diameter, with thick brown, bark-like skin and a distinct pointed nipple towards the apex. It contains one large seed surrounded by a layer of fibrous matter next to which is the orange coloured sweetish and slightly aromatic pulp. The flowers are small, cream-coloured and scented. They yield, by distillation, a spirit used in the flavouring of the liqueur Eau-de-Creole.

Sterculiaceæ.

57. *Theobroma cacao* Cacao.—A small tree 15–20 feet high with large oblong, pointed leaves, native of tropical America, cultivated extensively in its native home as well as in the West Indies, Gold Coast, Java and Ceylon. The tree bears a profusion of small pinkish or yellow flowers in bunches on the stem and older branhces, followed five or six months later by the ripe fruit. The latter is a large waxy pod six to nine inches long, red, yellow or grey when ripe. Each contains from 25 to 30 large seeds closely packed in a central column and covered with a white mucilaginous substance.

Verbenaceæ.

58. *Citharexylum spinosum* Bois fidèle or Fiddlewood.—From Lesser Antilles. Conspicuous during October and early November on account of the orange-red (autumn tinted) foliage. It is semi-deciduous for a brief period.

59. *Duranta repens* Pigeon Berry.—Introduced from Central America. Flowers over a long period but is conspicuous from September to December.

60. *Tectona grandis* Teak.—A native of Burma and Siam. Tree gregarious. Yields one of the most important timbers of the tropics. The best teak is considered to be that grown on calcareous soil. A tall erect and handsome tree with large leaves.

WEEDS AND GRASSES.

A few of the weeds and grasses to be found in the Gardens are listed.

Compositæ.

1. *Ageratum conyzoides* Goatweed.—Originally in Tropical South America but has since been introduced in all hot countries. An annual with a strong, objectionable odour.

Compositæ.

2. *Elephantopus tomentosus* Tobacco Weed. Tropical America. Also known as Elephant's Foot—one of the noxious weeds of Fiji—only a few small plants are in the Gardens.

3. *Emilia sonchifolia*—Grows in all trocal countries as a common weed of cultivated and waste places.

4. *Erigeron canadensis*—Cosmopolitan, but originally from temperate North America.

Compositæ.

5. *Mikania micrantha* Mile-a-minute.—Tropical South America. This climbing plant occurs in neglected corners of the garden—elsewhere it is a major weed in forest clearings, river pastures and plantations.

6. *Synedrella nodiflora.*—Originally found only in tropical America but it has now found its way into all tropical countries. A small weed of paths with insignificant yellow flowers.

7. *Vernonia cinerea* Tropical Asia.—A widespread weed common on foothpaths.

Leguminosæ.

8. *Alysicarpus vaginalis* Indian orient.—A small prostrate plant, with leaves with sheathing petioles, flowers purple and fruits crowded on ends of stems. The one-leaf clover—a useful component of pastures in many parts of the Colony.

9. *Desmodium triflorum* Tropical trefoil.—Cosmopolitan in tropics. This is a prostrate plant with small trifoliate (clover-like) leaves, small purple flowers borne singly on the leaf axils and small lomentum or seed pod. A useful species in turf.

10. *Mimosa pudica* Sensitive Plant.—From Brazil. This well-known plant is very common throughout Fiji. At a touch or on being disturbed, the leaflets and pinnæ droop suddenly—owing to a change in cell turgidity in the pulvinus at the base of the petiole. The leaves are pinnate—the flowers in pink globular heads.

Lythraceæ.

11. *Cuphea carthaginensis* Tarweed.—Introduced from the West Indies and Central America. A common weed of damp fields and waste places. Stem bears sticky glandular hairs on which insects are caught. Flowers small, magenta in colour, seeds small and black, in elastic capsules.

Gramineæ.

12. *Cynodon dactylon,* Bermuda or Couch Grass.—In the gardens a weed of paths and flower beds rather than a lawn grass. In the dry zone of Fiji makes excellent turf for playing greens.

13. *Dicanthium nodosum* Blue grass.—This species is the largest of the Dicanthiums found in Fiji. In the Gardens it occurs as a weed of turf. In the dry zone of Viti Levu it is grown as a fodder for stock.

14. *Echinochloa colona* Barnyard Millet.—Tropics and sub-tropics. Everywhere in drains and on edges of paths—a common weed.

15. *Eleusine indica* Crowfoot Grass, called *Vorovoro i sivi* by the Fijians, i.e. the spade breaker, because of its firm hold in the ground. A very common wayside weed.

16. *Paspalum conjugatum* Sour grass.—Tropics. A wide-spread weed, also common in turf in the wet area.

17. *Paspalum dilatatum* Paspalum.—Southern parts of South America. A common roadside weed and pasture grass.

18. *Ischæmum aristatum* Batiki Blue grass.—This species is now a major component of the turf in the Gardens, having spread since 1945 over a large part of the grassed areas. It has also considerable value as a pasture grass and is a useful species for soil conservation work or for playing grounds.

Cyperaceæ.

19. *Cyperus rotundus* Nut Grass.—Common in the tropics and sub-tropics. A bad weed of cultivated land in Fiji—also common in pastures and grasslands.

20. *Kyllinga brevifolia*—Tropical and sub-tropical regions. One of the components of the turf in the Gardens.

21. *Kyllinga monocephala*—Warmer parts of the Old World.

Campanulaceæ.

22. *Isotoma longiflora* Star of Bethlehem.—A succulent plant with coarsely toothed leaves and conspicuous white flowers, tube several inches long, limb star-like, 5-lobed. The plant exudes a poisonous white sap. Not uncommon on banks and well-drained places.

Polygalaceæ.

23. *Polygala paniculata*—A wide-spread weed with panicles of small white flowers. The roots are characterised by an aromatic perfume.

Urticaceae.

24. *Pilea muscosa* The Artillery Plant.—Of moss-like appearance. it occurs everywhere. It may be found as an epiphyte on the spreading base of the Royal Palm or along the paths and borders. The explosive mechanism whereby this plant spreads its minute seeds, and from which it derives its common name, is generally well known.

Plantaginaceæ.

25. *Plantago major* Plantain.—Originally from the northern temperate zone but has now been introduced everywhere. Common in Suva.

Malvaceæ.

26. *Sida rhombifolia* Paddy's Lucerne.—Tropics.

Solanaceæ.

27. *Solanum torvum* Prickly Solanum.—Cosmopolitan tropics. One of the major noxious weeds of Fiji—one or two plants occur in the gardens. A thorny shrub with large variously lobed hairy leaves and conspicuous thorns on midribs and on banches. Flowers white—fruit a berry.

ORCHIDS.

There are a few, self-established orchids in the Gardens.

1. *Taeniophyllum fasciolum* (*Denicaucau* or Dust of the Land-breeze) is a small leafless species with flat fleshy pale-green rhizomes creeping in a radiate manner over the bark of Ivi trees and bearing small cream, short-stalked flowers. Despite its minute size this plant is extremely interesting.

2. *Grammatophyllum speciosum* is a native of the the Solomon Islands and has become established on a number of trees in the area as an escape from gardens. It is a very large and robust plant with enormous masses of rhizomes amd large erect leathery leaves. The inflorescences are several feet long, bearing racemes of large greenish brown spotted flowers nearly two inches across.

3. *Oberonia glandulosa,* a tufted plant, 9–12 inches high, with flat pendulous leaves and curved racemes of small crowded cream-coloured flowers forming an elongate tassel, commonly growing on Gourd and Ivi trees.

FERNS AND FERN ALLIES.

Amongst the fern-allies other than the indigenous *Cycas* are the very interesting specimens of *Ophioglossum* and *Psilotum* which are both natives of Fiji.

Hanging in graceful streamers from some of the Ivi trees is *Ophioglossum pendulum,* known to the Fijians as *Yamenigata* and growing in the turf of the main lawns is *O. reticulatum* with a single leaf and sporangium borne on a short stalk.

Psilotum nudum, specimens of which may be found on the large *Cassia fistula,* is a plant with very ancient associations. Its many-branched leafless stems tipped with small sporangia, give this plant a very characteristic appearance.

Of true ferns the following are common in the Gardens—all self-sown and epiphytic on the trees and palms.

Cyclophorus adnascens, known to the Fijians as *Moko moko ni Ivi,* i.e. The Ivi tree's girdle. These climbing epiphytes are very common on Ivi trees, raintrees and elsewhere. The simple oval or oblong—lanceolate fronds covered on the dorsal surface with abundant sporangia often clothe the trunks and branches of large trees.

Davallia feejeensis, called by the Fijians *Ai vutu me ra kula,* that is the Yangona strainer of Sir Kula—the Fiji parakeet. This is a beautiful species with large coriaceous bright green and golden fronds, some of which are very finely and others more coarsely divided. There are good specimens growing at the bases of the Royal Palms.

Drynaria rigidula, growing high up on trees where it collects humus by means of dry, brown, lobed oak-like leaves. The fertile leaves are sub-erect with long linear pinnæ, densely reticulated veins and uniserial, round sori. This is one of the so-called basket or bird-nest ferns.

Goniophlebium subauriculatum.—Another of the basket ferns called by the Fijians *Ai davudavu ni gata,* or Snake's Nest, is a conspicuous perching fern—a good specimen of which is to be found on the large *Cycas* near the Clock Tower.

Nephrolepia hirsutula, one of the Boston ferns—with long lanceolate pinnate fronds, which the Fijians call *Waruwaruirakula*, Sir Kula's lash.

The Polypody Ferns are represented by *Phymatodes scolopendria*, called *Vativati* locally, and common as an epiphyte on the base of the Golden Cane palms. The fronds are used in native medicine.

Vaginularia angustissima, a grass-like epiphyte growing in pendulous tufts on the branches of trees.

Vittaria elongata which rejoices in the name Ogre's Beard, is very common and easily recognized by the leathery dark green very narrow fronds with recurved edges containing the sporangia and by its habit of curling up in dry weather to revive again when the air is sufficiently moist.

ACKNOWLEDGEMENTS.

The beautiful photographs of trees and palms which illustrate this account of the Suva Gardens are the work of Mr. R. Wright of the Public Relations Office.

REFERENCES.

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FIJI AND WESTERN PACIFIC RESEARCH COUNCIL.

At the second meeting of the Fiji and Western Pacific Research Council, held on November 10th, it was recommended that application should now be made for grants to cover the following schemes:—

(1) A five year scheme for biochemical investigation concerned with animal nutrition in Fiji; £F12,500.

(2) A five-year scheme for botanical investigations in Fiji and the Western Pacific High Commission territories; £F14,000.

(3) A five-year scheme for investigations concerned with the nature and control of plant diseases in Fiji; £F12,500.

SUGAR.

H.M. Government has given a five-year guarantee to Fiji and other Commonwealth countries in respect of their exportable production of sugar, which will be effective from January 1st, 1948. Prices will, unless otherwise arranged, be negotiated annually having regard to world market conditions and all other factors.

The C.S.R. Coy. Ltd. paid on December 1st interim dividends amounting to 18s. a share. The half-yearly report of the company states that the Australian sugar crop this season is expected to yield 910,000 tons of raw sugar, which would be a record, and 14 per cent more than their pre-crushing estimate. There has also been a favourable season in Fiji and an increase of six per cent to 136,000 tons is now expected. The company's report adds, however, that in spite of increased production, housewives and manufacturers have not received their full requirements owing to shortage of labour, insufficient coal and interrupted deliveries.

SOUTH PACIFIC COMMISSION.

His Excellency the Governor made reference in his speech delivered to Legislative Council on 11th November to the decision of the South Pacific Commission to locate its headquarters at Noumea instead of Suva. He congratulated at the same time the two Government officers for whom, in the face of very considerable competition, places have been secured on the South Pacific Research Council: they are Mr. Howard Hayden, Director of Education, and Mr. B. E. V. Parham, Senior Agricultural Officer.

YIELDS AND COMPOSITION OF LOCALLY-GROWN GRASSES AND LEGUMES *

Ref. No.	Name.	Sample cut		Average yield per annum (tons)		Composition					Remarks.
		Date	Age (weeks)	Green	Air dry	Fat	Crude fibre	Protein	Ash	N.F.E.	
....	Para grass (*Brachiaria mutica*)	7/3/47	87	41	14	0·61	38·9	5·56	8·91	46·0	In November, 1946—Protein = 2·6.
PR. 241	Rhodes grass (*Chloris gayana.*)	12/4/47	85	15	....	1·06	41·0	3·82	5·68	48·4	In December 1946—Protein = 3·1.
PR. 221	Woolly finger grass (*Digitaria melangiana.*)	30/3/47	52	20	7	2·20	38·2	4·88	15·75	49·0	In December 1946—Protein = 8·9.
PR.	Batiki blue grass (*Ischæmum aristatum*).	25/3/47	22	32	11	1·17	39·5	5·09	6·86	47·4	In August 1947—Protein = 4·09.
PR. 207	Molasses grass (*Melinis minutæflora.*)	24/1/47	86	18	5	1·04	42·6	3·71	6·41	46·2	In October 1946—Protein = 5·0; In December = 3·0 (different locality).
PR. 206	Kavirondo sorghum (*Sorghum verticelliflorum* var.)	4/3/47	23	40	....	1·80	36·6	8·45	9·60	43·6	First cut at 12 weeks yielded at rate 23½ tons pa green material
PR. 276	Kyasuwa grass (var. "Brown") (*Pennisetum pedicellatum*).	28/2/47	82	8	2·6	1·76	38·4	4·15	12·60	43·1	In September 1946—Protein = 4·9.
PR. 205	Guatemala grass (*Tripsacum laxum.*)	9/4/47	26	50	21	1·12	38·7	4·50	7·30	48·4	.....
PR. 1211	Calopo. (*Calopogonium muconoides.*)	22/10/46	68	7·5	1·5	2·50	37·8	14·60	8·14	37·0	In April 1947—Protein = 16·4 per cow.
PR. 1295	Puero. (*Pueraria phaseoloides.*)	17/1/47	73	13	3·5	1·07	42·1	15·70	7·57	33·6	In October 1946—Protein = 16·9. In December 1946—Protein = 15·8.
PR. 1307	Stylo. (*Stylosanthes guianensis*).	16/2/47	75	7·8	2·5	1·10	49·3	7·95	5·36	36·3	In October 1946—Protein = 14·2.
PR. 1226	Centro. (*Centrosema pubescens*).	9/10/46	58	11·5	3·0	1·2	43·4	17·4	7·16	30·8	.....

* Analyses by courtesy the Director, Plant Chemistry Laboratory, Plant Research Bureau, New Zealand.

Other analyses of locally grown grasses and legumes are given by McKeown(1) and Wright(2). These species dealt with are—*Eriochloa subglabra, Pennisetum* (*setosum*) *polyatachyon, Minosa pudica, Desmodium heterophyllum, Paspalum dilatatum, P. conjugatum, Panicum maximum, Eleusine indica* and *Mikania* (*scandens*) *micrantha.*

(1) McKeown, G.M., 1921: Grasses for Fiji, *Ag. Jour. Fiji,* Vol. 2, No. 4, 75.

(2) Wright, C. H., 1922: Notes on Grasses in Fiji, *ib.*, Vol. 3, No. 3, 40.

—B.E.V.P.

VETERINARY . . .

COMMON COMPLAINTS OF DOGS IN FIJI.

4. EAR TROUBLES AND TREATMENT OF WOUNDS.

BY K. J. GARNETT, B.V.Sc.

Many dogs particularly the long eared breeds suffer from an infection of the ear which results in irritation and discharge. If diagnosed early and treated, most cases respond very well, but there are some chronic cases which are most difficult to clear up. It is emphasised, however, that many chronic cases are due to improper or irregular treatment by the owners of the dogs.

The first symptoms noticed by the owner are that the dog may shake its head vigorously, often scratches at the ear, and if only one ear is affected, the head is often twisted to one side so that the affected ear is lower than its fellow. Examination of the ear will reveal a reddish-brown, moist exudate, and in some cases, if the ear is held firmly at its base and moved slightly, a "clicking" noise will be heard.

If the ear is not too tender, it is of considerable benefit to clean it out in the following manner: Tease out a small piece of cotton wool, grip it between a pair of forceps, and still holding the cotton wool twist the forceps until a pledget is formed. Care should be taken that the ends of the forceps are completely covered. If no forceps or tweezers are available, a piece of boxwood can be pared down to about the thickness of a match and the cotton wool twisted about its point, care again being taken to see that the end is completely covered. This is then gently inserted into the ear and moved about in the cavity, withdrawn and the cooton wool renewed. The process is repeated until the ear, as judged by the amount of exudate on the cotton wool, is clean. Owners need not worry about probing too deeply and injuring the ear drum, since the ear canal of a dog is curved and there is little chance of reaching the drum. The cotton wool used in the cleaning should be dry and not moistened in any way before insertion in the ear.

Cleaning of the ear with substances such as peroxide has certain disadvantages and is not to be recommended as a general rule.

Following the cleaning of the ear, a few drops of a seven per cent solution of Arvitin, Argyrol, or Sylvol into the affected ear has given good results in early cases. The dog should be firmly held while the drops are inserted, and the base of the ear moved about to ensure that the solution spreads over the canal. Most dogs shake their heads vigorously on being released, and care should be taken that clothes are not stained as a result.

The above treatment, including the cleaning of the ears should be carried out twice daily until the exudation in the ear ceases. The dog should then be checked at regular intervals to see that the cure has not been a temporary one.

In addition to the solutions mentioned above the following may be used with good chances of effecting a cure: a mixture of mercurochrome in glycerine. Various antiseptic and astringent powders which must be in a finely divided state and are better used with the aid of a puffer or blower.

WOUND TREATMENT.

Dogs and cats present certain very great difficulties when it comes to treating their injuries. In the first place they have a coat of hair which often becomes matted in the wound and from which particles of dirt and dust can enter and infect the wound. Bandaging the injury is difficult, especially as the animals will worry at the bandage until they have removed or loosened it. Finally, it is nearly impossible to prevent animals from licking their injuries and so rapidly removing any dressing applied before it has an opportunity to do much good.

With these limitations in mind, a few general principles will be given.

Where wounds are of a superficial or minor nature, the hair should be clipped from about the wound, care being taken that none of the hair falls into the injury. The wound should then be bathed with a weak antiseptic solution. Dettol, Solyptol Lysol, Eusol or Acriflavine are some of many suitable antiseptics, and if none of these are available, a little common salt dissolved in water is an excellent cleansing agent. All shreds of skin and tissue should be removed, also coagulated blood as these will be sources of later infection. The wound can then be dressed with a little powder such as zinc oxide to which a little iodoform has been added, or boracic acid with iodoform. Sulphonamide powders are most effective dressings. Many wounds respond better if ointments are used and here again, sulphonamide ointments, or zinc oxide ointments and the like are highly effective if not removed too quickly by the animal licking the injury. Iodine and such other irritant dressings are contraindicated at this stage, but are most useful in a special case to be described later.

Where the wounds are larger, deeper, or are of longer standing with the result that infection has set in with swelling or pus formation, the wound should be clipped and cleaned as before. If the area is not very swollen, the local application of sulphonamide ointment or powder is usually fairly effective. It has also been found that the ointment results in the more rapid closing over of wounds in which a fairly large area of skin has been lost or damaged. The addition of cod liver oil to sulphanilamide ointment has also proved very useful in wounds which extend to the deeper structures but only have a small opening in the skin surface, since the ointment tends to become more of a cream and is more easily inserted to reach the depths of the wound, particularly if a blunt nozzled syringe is used.

In some wounds, such as after a knock from a car, there is often considerable swelling present in the affected area. The swelling may be due to the injury of the tissues only, and there may not be any secondary swelling as a result of bacteria establishing themselves in the damaged tissues. Where the bacteria establish themselves pus is formed as a result of the breakdown of the injured tissues, and if this forms into a pocket, an abscess is formed which is usually well marked off from the surrounding healthy tissue. It sometimes happens that the breakdown products spread along between the other healthy tissues in the region which results in a more diffuse swelling and the production of a cellulitis. A cellulitis can be recognised in that if a finger is pressed firmly on the skin above it and removed, a depression will remain for several minutes. It is an advantage to know whether a large swollen area, with or without a break in the skin above it has been invaded by bacteria, and for this reason the temperature of the dog should be taken since a temperature of about 102·5 or over will indicate that bacterial agents are at work in the deeper structures of the body. If the temperature is raised as above, the animal should receive a course of sulphonamides as indicated in the article on Distemper i.e. One tablet per seven pounds of body weight each day for five days. If there is also a break in the skin above the swelling, this should also be packed with sulphanilamide powder or ointment. Whether or not infection is present in the swelling, the value of hot fomentation cannot be overemphasised. If there is no infection present, the use of hot fomentation will stimulate the supply of blood to the region and so hasten the removal of damaged tissues and products of inflammation with the result that the swelling is rapidly reduced and the increased blood supply also means a greater supply of repair cells from the blood being made available in the region. Where infection is present in the form of an abscess or cellulitis, hot fomentation assists in one of two ways. In the first instance, the increased blood supply may result in the body absorbing the damaged tissues, bacteria and their breakdown products, and as these enter the bloodstream they are engaged by bacteria-fighting cells in the blood and are further attacked by the sulphonamides which although given by mouth, quickly enter the bloodstream to join in the combat. In the second case, particularly

where a large abscess has been formed, the body builds up a defensive barrier around the abscess which is eventually allowed to break out and discharge. It is important that this discharge should be out through the skin to the exterior and not internally into one of the body cavities. The discharge to the surface can be considerably hastened by the application of hot fomentation which assists the abscess in "pointing". In some cases the process can be still further hastened by the incision of the abscess, but this is not advisable until the abscess has commenced to "point". This incision can be made with any clean, sharp knife or razor blade which has previously been soaked in disinfectant. The abscess should not be incised too soon or there is likely to be considerable haermorrhage Once open, the abscess should be thoroughly cleaned and packed with sulphonamides as before. The dressing should be carried out as often as necessary, but should be at least twice daily at first. It will be seen that even in these days of sulphonamides and penicillin, there is still a very important place for hot fomentation, and since very few people derive full benefit from it because of improper or insufficient application, the process will be briefly described.

Within reason, the hotter the water, the more effective the treatment, but care should be taken that the water is not too hot or the patient will be scalded. A good guide is the back of one's own hand. Since most animals resist at first, particularly if the water is a little hot, a good idea is to start with the water only warm, and then add more hot water to bring up the temperature to that required. The important point is that the fomentation must last at least twenty minutes on each occasion. It should be remembered that in this period the water will cool off considerably so that a further supply of hot water must be available to add to that which is cooling off. The longer and more frequent the fomentations, the quicker the desired effect will be obtained, but at least two or three twenty minutes applications should be given daily. The actual method of application varies. An old towel or cloth is soaked in the hot water, wrung out and quickly wrapped around or over the affected part and held there until it starts to cool off, when the process is repeated. It is an advantage to have the compress folded several times so that it is thick. Another towel wrapped around the area helps by preventing the loss of too much heat. Another method is to apply the compress as above but instead of removing it for further soaking, to remove only the top towel which should be dry, and then to pour a little of the hot water on to the pad used for the actual fomentation, after which the top towel is again folded into place. This latter method is highly effective, but the excessive water makes a mess unless provision is made for drainage. Finally, if an extremity, such as a paw is involved, the whole foot can be immersed in a basin of hot water without any towels or pads.

Hot fomentation is greatly assisted by gentle massage, but care should be taken that this is in the direction of the return blood flow, that is, up to the leg towards the body, never down the leg away from the trunk. A gentle squeezing action is best, similar, but in the opposite direction to that used when milking a cow.

Provided there are no further complications, the methods outlined above for the types of wounds mentioned should give fairly good results, particularly if the dog is in good health and well cared for in other respects. Failure, or considerable delay in the complete healing of a wound is occasionally met with. This is frequently caused by a small pocket of infection remaining in the depths of the wound, and even though the skin may close over for a short period it will break out again and continue to discharge a small quantity of pus for weeks. It is advisable to seek the advice of a Veterinarian in such cases.

In other cases, particularly where the original injury has involved a fairly large skin surface and the healing has been delayed by infection, or where the injury is in the region of a joint, healing processes become more protracted after a time and the wound is then referred to as being "indolent." Such cases should not occur if dressing has been carried out effectively on the lines indicated, but if they do occur, the wound can be stimulated by painting it with iodine for two or three days. Care

should be taken, however, that there is no pocket of infection in the depths of the wound since it is useless to close over a wound if the pocket is to cause it to break out again

Where the animals have been more seriously injured and there is a likelihood of shock, internal injuries, broken bones or joint injuries, the animal should be removed as quietly and with as little handling as possible to a warm, darkened room and a Veterinarian contacted immediately.

Finally a few words of advice. If a wound is bleeding or likely to start bleeding again, cold water should be used in cleaning up the wound since hot water causes the blood vessels to enlarge and so delays clotting. Cold water constricts the blood vessels with the result that there is a better chance of them clotting. After a day or two, particularly if the wound is swollen or infected, hot water is indicated.

Free drainage from a wound is essential, so that if the nature of a wound is such that a pocket is formed with its opening high enough to prevent the free gravitation of the pus from the wound, it is necessary to enlarge the opening downwards until this drainage is obtained. If this would involve too big an incision a new opening should be made at the required level and attempts made to close over the original opening.

If a bandage is used to cover a wound on a leg, the owner should see that it is not too tight since this will flatten the thinner walled veins, while the thicker walled arteries continue to carry blood which will collect in, and distend the leg below the bandage. A safe precaution, particularly as a bandage soon falls off if too loose, is to bandage the whole leg, including the paw, below the original level at which the bandage would have been applied. This will prevent the distension of the lower part of limb mentioned above.

In outlying areas, where no Veterinarian is available, many owners have successfully set broken legs in splints. A good splint is made from a piece of split bamboo, since it is light and strong, and the curve fits into the shape of the leg. It is essential, however, that the bamboo be covered with a thin layer of cotton wool, particularly the ends, which should be shaped so that there is no chance of them causing irritation to the areas above or below the break. Here again, the bandage should go right down the leg and over the paw, and in cases where the limb was badly swollen at the time of setting, a check should be made see that the subsequent reduction in this swelling does not cause the bandages to become too loose. The splints should not be removed or interfered with unless absolutely necessary, and should remain in place for approximately three weeks.

MATING DOMESTIC ANIMALS.

By K. J. GARNETT, B.V.Sc.

A certain amount of confusion appears to be present in relation to the ages and periods in the lives of the various domestic animals which are most suitable for them to be mated in order to produce young. This article is intended to summarise the position, but it should be remembered that there are often marked variations in the breeding cycles which are often very susceptible to the effects of disease, methods of management and nutrition, and also climate.

Dealing with each of the animals in turn, the details are as follows:—

HORSES.

Mares usually comes on heat again five to twelve days after dropping a foal, and unless pregancy or some other factor interferes, they will continue to come on "heat" at approximately twenty-one day intervals. The actual "heat" period or oestrus usually lasts between five and nine days, and since ovulation or the release of the ovum or egg from the ovary occurs approximately two days before the end of oestrus and ovulation and deposition of the semen by the male results in greatest fertility if both occur at approximately the same time, the aim should be to serve the mare twenty four to forty eight hours before the end of œstrus, i.e. five to six days after the commencement of œstrus for most mares. As stated, the cycles occur at approximately

twenty one day intervals. They are most pronounced in the spring and usually cease altogether in the autumn and winter months. For this reason, mating in Fiji should occur between August and December for best results.

The gestation period for mares is usually 334 to 339 days with limits of a minimum of 300 days and a maximum of 380 days if the foal is to survive. For general purposes, a period of eleven months is used.

Fillies first come on " heat " when they are about a year old, but they should be at least three years old before being mated, since slight growth does occur in a mare until she is six to seven years old even when she is well fed. Provided she is over three years old, healthy and well fed, a mare is capable of producing a foal each year for up to twenty years or more.

When born, the testicles of a colt are usually in the abdominal cavity and descend through the inguinal canal into the scrotum in the first year. Cases do occur, however, where one or both of the " stones " may not come down for several years and sometimes, not at all. These animals are known as cryptorchids or " rigs ".

In the event of normal descent of the testes, stallions may be fertile at approximately one year, but should not be used they are at least two and preferably three years or over. A vigorous and well-grown stallion of three years can cover up to forty mares in a season, and at four years and over, eighty mares.

Sterilisation of mares can be effected at any age by making an incision through the dorsal fornix of the vagina and removing the ovaries.

Sterilisation of stallions usually done between the ages of one or two years although they can be castrated any time later in life. In Fiji, the Stock Improvement Ordinance requires that all male horses should be either castrated or licensed as stallions before they reach the age of two years.

CATTLE.

Cows, after calving, normally come on " heat " some thirty to sixty days later. Each cycle occupies approximately twenty-one days, but unlike mares, the true " heat " period usually lasts not more than twenty four hours and sometimes less Ovulation usually occurs some eleven to thirty hours after œstrus, but in view of the short " heat " period and the fact that after deposition, the sperms will live in that female genital tract for approximately three days, it is advised that service take place nine or ten hours after the commencement of œstrus. A further important point of difference, is that cows, unlike mares, will come on " heat " at any time of the year and will continue on a three weekly cycle until pregnancy or some other factor such as disease, interferes.

The gestation period for cows is 283 days with minimum and maximum limits of 262 and 303 days for likely survival of the calf. Generally speaking, the period is nine months.

Heifers first come on " heat " as early as six months in some cases, but depending on their growth and breed it is not advised that they be mated until they are fifteen or eighteen months or even later with dairy heifers in Fiji. Beef heifers should be left even longer since they should be somewhere near their maximum size before having to stand up to the strain of pregnancy.

Depending on feed available, management and subsequent mating, cows in Fiji are normally milked for six to ten months, although they will go on for considerably longer periods of lacatation, and there are many cases where cows again calve while still being milked on the lacatation resulting from the previous calf. Such a practice is not advised since a spell of six to eight weeks is desirable for the cow to build up for the strain of the next parturition and lactation. Generally speaking, the aims should be to have the cow milk for about ten months, rest for two months and then start her next lacatation. There are cases of cows approaching thirty years of age which have produced up to twenty five calves.

The testicles of young bulls are normally present in the scrotum from birth. They become fertile at approximately a year old, but should not be used in Fiji until they

are about two and a half years old. An active bull over three years old should cover up to forty cows a year. They may cover more, but fertility declines with excessive use.

Sterilisation of cows is usually effected by stockmen by cutting through the left flank and removing the ovaries, but may also be done through the vagina as in mares. Heifers up to six months can be speyed by an incision in the inguinal region.

Bulls can be castrated at any age, but are best done under one year old. The Stock Improvement Ordinance in Fiji requires that all bulls over one year must be either licensed or castrated.

SHEEP.

The cycle in the ewe lasts between fifteen and eighteen days and the actual period of œstrus varies in different breeds, but is usually considered to last between twenty four and forty hours. Cycles may occur over most of the year, but are usually most marked over periods of several months in both spring and autumn. The usual aim is to have the lambing take place in as short a time as possible in early spring so that rams are usually joined with the ewes for a period of six to eight weeks in autumn. As mentioned "heat" lasts twenty-four to forty hours and ovulation is usually at the end or soon after this period and maximum fertility results if the mating occurs nine to twenty four hours after the commencement of œstrus.

The gestation period of the ewe is between 148 and 150 days, and is usually taken as five months.

Ewe lambs will come on "heat" and become pregnant at about eight months. but are best kept until over a year old before being mated.

Lambs are usually "marked" i.e. tails amputated and in males, testicles removed, at about eight weeks. Ram lambs are fertile at about six months, but should not be used until they are at least one, and preferably, two years old. Depending on the breed, type of country and general management, it is usual to allow one ram to fifty or a hundred or more ewes.

GOATS.

In general, the breeding systems in goats follow those of sheep fairly closely. The cycle lasts two to three weeks, depending on breed and conditions, but œstrus itself is usually shorter than in sheep in that it only lasts a few hours.

The duration of pregnancy is five months as in sheep and ages of fertility and maturity are very similar.

PIGS.

Sows follow a cycle of approximately three weeks. Oestrus lasts forty to sixty hours with ovulation occurring at the end or shortly after that period. For this reason mating should take place eighteen to thirty hours after the commencement of œstrus to ensure maximum fertility. Sows continue to come on "heat" the year round at three weekly intervals unless they become pregnant.

The gestation period in sows is 114 days and can easily be remembered as three months three weeks and three days.

Both boars and sows are fertile at about eight months but should be at least a year old before being used for breeding. It is usual to arrange management so that each sow produces two litters a year, and the desirability of staggering the farrowing of various sows in order to ensure an even and complete demand and utilisation of available foodstuffs cannot be too highly stressed.

An active boar can cover up to thirty sows but should always have at least a day or two between services, since fertility in a boar rapidly decreases when used excessively although it again improves with rest.

Young boars are usually castrated at one or two months.

Of interest is the fact that if two different boars serve the same sow within a short time of each other in the same "heat" period, the resulting litter may contain piglets by each sire.

DOGS.

Bitches come on "heat" twice a year, and the duration including the slight bleeding that takes place is usually from nine to seventeen days although true oestrus

is for the last three or four days of that time only, and it is in this last three or four days that conception is most likely to occur following service, since ovulation usually takes place a day or two after the end of the visible heat period, and although bitches may not stand for a male at this stage, it is advisable to restrict a female for several days after visible signs disappear if mating is not desired.

The gestation period in a bitch is fifty eight to sixty-five days or approximately nine weeks.

Bitches first come on " heat " at about six months. Males are born with the testes undescended and they are found in the scrotum at about four months. Dogs are commonly castrated in Fiji, and the best age for this operation is about six months. Dogs become fertile at about six months.

Bitches should be six months old before being sterlised, but the operation can be performed at any age provided that the animal is still in good health. The fact that she has had one or more litters makes no difference to the effectiveness of a subsequent operation.

As in pigs, a bitch may produce pups in the one litter in which there can be more than one father. The widespread belief that if a purebred animal is accidentally mated with a male of a different breed, that subsequent young from the same female and a pure male of the same breed, will be " tainted " by the previous mating is absolutely without foundation in all animals.

CATS.

Here, as in dogs, the female comes on " heat " twice in each year, each period of heat lasting about four to five days.

Cats are peculiar in that some stimulus is required to produce ovulation, and in most cases this is coitus or the actual service by the male. As a result, the chances of a pregnancy resulting from coitus at any time in the " heat " period are very good.

The gestation period is 56 to 58 days in most cats although Siamese cats usually take up to 64 days. In general, the period is usually referred to as eight weeks.

Females first come on " heat " at about five to six months and males become fertile at about the same time. Females can be speyed any time after they are four months old. Males are best castrated at about four months, but the operation can be performed at any later stage in life.

FOWLS.

Depending on the season, feeding and general management pullets will commence to lay at about five months, and for this reason, in Fiji, eggs should be set between July and September in order that the pullets produced will commence to lay in February.

Fowls will continue to lay eggs irrespective of whether a male is present, although eggs produced without a male being present within the limits described below are naturally infertile, although perfectly good for eating. Following service by a male, hens are able to store the semen of the rooster in a special " sac " and from this, each egg is fertilised in turn as it passes down the oviduct. Eggs laid thirty hours after a rooster has been first introduced, may be fertile, but maximum fertility is not reached for some five to seven days and there are usually further services in that period. After removal of the rooster, fertility does not decrease until after the sixth day. At the tenth day after removal, it is found that about fifty per cent of the eggs are fertile. This fertility decreases to about fifteen per cent on the nineteenth day, and it has been recorded that fertile eggs have been produced up to twenty-six days after the removal of the rooster. Introduction of a second rooster following the removal of the first, hastens the decline in fertility of the semen from the previous rooster, but where selective breeding is taking place with the aim of breeding from a certain rooster after hens have been running with other cockerels, it is advised that three weeks be allowed to elapse from the introduction of the desired cock until the eggs are set. If the hens have been alone eggs can be set five to seven days after the introduction of the rooster.

A vigorous cock will tread up to thirty or forty hens in a day, but such excessive use markedly decreasses his fertility, and in breeding pens it is advised that each rooster be allowed eight hens only.

Of practical interest is the fact that provided conditions such as climate, feed and general management are the same, the average yearly production per hen drops by approximately thirty eggs each season. In other words, a hen commencing her third laying season would be expected to produce sixty fewer eggs than a similar pullet commencing her first laying season. This represents five dozen eggs, and at the high current price for eggs, with feed expensive and at times, hard to get, also the necessity of feeding a hen through an unprofitable moult between seasons, and finally, the high market value for even third year hens for table purposes, all combine to make it a rule to cull birds which have completed their second laying season.

In conclusion, the gestation and hatching time for the various more common animals and birds are summarised below—

Elephants	21 months.
Camels	11½ ,,
Donkeys	11½ to 12½mths.
Mares	11 months.
Cows	9 ,,
Ewes	5 ,,
Goats	5 ,,
Sows	3 mths. 3 wks. 3 days.
Bitch	9 weeks.
Siamese cat	9 ,,
Cat	8 ,,
Rabbit	32 days.
Guinea Pig	63 ,,
Rats	22 to 33 days
Mice	19 days.
Muscovy Ducks	5 weeks.
Ducks	28 days,
Geese	28 days.
Turkeys	28 days.
Guinea Hen	25 days.
Hen	21 days.
Pigeon	18 days.
Canary	14 days.

MECHANIZATION IN THE AFRICAN COLONIES

Greatly increased interest in the mechanization of agriculture has been shown in the African colonies since the war, not only by planners, Government officials and estate owners, but also by the native farmers themselves, many of whom have served abroad in the armed forces and seen the benefits of mechanization. Although the amount of agricultural machinery which has so far been permitted to reach this market since the war is negligible, the time will come when it will obviously be of considerable interest to British manufacturers.

It is the more important, however, to consider its needs now, because its special requirements seem to be so little realized, and because British products are currently so often less suitable to it than American ones. The central fact to grasp is that the main demand for tractors and tractor-drawn implements is likely to be for either the very heavy or the very light types, with a much smaller place for the medium size, which forms the bulk of production for the British home market.

The most important agricultural areas of the tropics are naturally the regions of high rainfall, where the vegetation is correspondingly dense, and over a large proportion of these areas the soils are also pretty heavy. For example, in the most fertile area of Uganda, where the elephant grass (*Pennisetum purpureum*) stands as high as a man's head, the lightest tackle which experience has found able to plough new ground is a crawler tractor of 35 or greater h.p. pulling a disc plough.

Under slightly easier conditions, there will be plenty of scope for tractors of the 28 to 30 h.p. class, especially those which can be fitted with a track or half-track. These will also be much in demand by estates for after-cultivations on land opened by heavier tackle. But it is difficult at present to foresee so much scope for tractors

of, say, the 12 to 20 h.p. class, which have formed a large proportion of British production.

On the level of native peasant farming, the demand is likely to be for tractors of the 6 h.p. class and downward, even to the little " motor hoes ". These machines would even now be financially within reach of some of the richer farmers in certain African territories. It is often said that the only economic way to mechanize peasant holdings is for the machines to be bought by co-operate societies, collective groups, or contractors who will hire them out; but, even so, where each family has only four or five acres under cultivation, a 6 h.p. tractor will be enough for quite a large group to buy and it is doubtful how far we should think in terms of larger machines. In humid regions, this does, of course, mean that initial clearing will still have to be by hand, and only after-cultivations by machinery.

A number of special demands are made on machinery under colonial conditions. Ant-hills are frequent obstacles in the way of cultivation, and so are imperfectly cleared tree roots and boulders embedded in the soil. Under the system of shifting cultivation, a man does not know his fields, and where outcrops of rock occur in them, with the intimacy of a British farmer. The machines least likely to get into trouble with these obstacles are probably either the very heavy or the very light ones. In the few trials that have been made, there have been a disappointing number of breakages with 6 h.p. tractors, and it is evident that greater strength will have to be provided, difficult as it may be in these light machines.

Water is another difficulty. A casual native driver may so easily ruin a tractor by forgetting to fill the radiator; or, in times of drought, the nearest water supply may be many miles away. This places a machine with an air-cooled engine at an advantage compared with other tractors of its class. Another problem is shown by reports from Kenya that at least one British tractor, of otherwise adequate horse power, has insufficient power for use at high altitudes. Very sandy soils offer different problems again from the heavy ones; wheeled tractors slip except in wet weather, and on crawler types, track wear is excessive.

Another aspect that bears consideration is that, to the native peasant, the mechanization of crop processing may be equally or more important than that of cultivation. A Belgian expert in the Congo has calculated that 38 per cent of all work done in crop production is expended on processing after harvest, as against nine per cent spent in initial clearing of land, 19 per cent in cultivation, and 34 per cent in harvesting.

This processing, which is such a burden on the tropical peasant and his wife, consists in such operations as shelling and grinding maize, hulling rice, shelling groundnuts, pounding millets or cassava into flour, hulling sun-dried coffee—to take only a few examples. Here is a " sellers' market " awaiting whoever can produce the right machinery cheaply enough to meet a great potential demand and a very human need.

Agriculturists in the Colonies are perhaps apt to be querulous when their particular demands are not met, and to some extent, of course, individual areas must always make do with what suits the larger demand; on the other hand, the potentialities of development in these areas are making market research by designers and manufacturers steadily more desirable.

REFERENCE.

G. B. Masefield, in Farm Implement and Machinery Review, Vol. 73, No. 875, p. 1083, 1948.

SLUGS AND SNAILS.

Slugs and snails are perhaps the best known of all the pests that attack cultivated plants. Every year they are the cause of serious damage, not only in gardens and allotments, but also on farms. Few crops escape their attention. They destroy almost all kinds of flowers and vegetables; and, among farm crops, cereals, peas, clover, swedes and other root crops often suffer severe damage, especially in the seedling stage. Certain species of slugs are also frequently responsible for spoiling a large proportion of potato crops, eating out holes in the tubers.

DESCRIPTION.

The commonest and most widely distributed species of Snail in gardens is the *Large Garden Snail*[1], easily distinguishable by its large grey-brown shell with paler markings.

The *Strawberry Snail*[2] is much smaller, seldom more than ½ in. long; the shell is flatter and varies in colour from dirty-grey to reddish-brown or brown. It is sometimes specially troublesome in strawberry beds and among violets, iris and other garden plants.

The *Banded Snails*[3] are injurious to clover and sainfoin and upland pastures; the shell may be white, grey, pale yellow, pink or brown, with one to five spiral darker bands.

The most generally harmful Slugs are:

The *Field Slugs*[4], variable in colour but usually mottled grey with a reddish or yellow tinge; it is probably the most uniformly and generally injurious slug throughout the country.

The *Garden Slug*[5], a small dark species with a yellow foot and a very tough skin, common both in gardens and fields.

The *White-soled Slug*[6], also a small species, usually grey in colour with a flattened appearance and with a strikingly white foot.

The *Keeled Slugs*[7], dark brown or grey with the body keeled along the back: these are very troublesome species largely subterranean in their habits, feeding on the underground parts of plants and often specially injurious to potatoes.

The *Large Black Slug*[8], less commonly injurious to cultivated plants but sometimes causing damage.

HABITS.

The feeding habits of the different species vary slightly. Some eat mainly leaves and stems well above ground; others feed chiefly at the soil level, tunnelling into the bases of plants, and others attack mainly roots and tubers below ground. But all can and do devour indiscriminately any succulent plant tissue.

Both slugs and snails feed chiefly at night. Almost any place that is cool, moist, and dark, gives suitable shelter during the day.

Slugs burrow into the soil in dry or cold weather, and continue to feed throughout the year whenever temperature and moisture conditions are not too unfavourable.

Snails, however, hibernate during the winter, collecting in clusters in dry, sheltered spots.

A very important characteristic of both slugs and snails, is the power of excreting a slime which assists them in crawling and also enables them to get rid of any irritating substance which may fall upon them. This faculty and their nocturnal habits, make them specially difficult to control.

PREVALENCE.

The development of slugs is influenced predominantly by the moisture conditions of their environment. In seasons of high rainfall they are most numerous, and wet, mild winters enable them to continue feeding and reproducing throughout the year. Similarly, soils of high water-holding capacity provide very suitable conditions. Periods of dry or frosty weather are definitely adverse but as soon as rain falls and the temperature rises, feeding and other activities are fully resumed.

The presence of an abundance of organic matter is specially advantageous. Not only does it increase the water-holding power of the soil, but it also serves as a store of food for the slugs during times when few plants may be available.

Soils which continually receive dressings of farmyard manure, garden refuse, green manures, spent hops, etc., are therefore particularly liable to infestation by these pests. Slugs are also often very numerous of heavy sour soils, but observations have shown that the reaction of the soil is not itself a factor that normally influences their prevalence; acid, neutral, and alkaline soils may all be heavily infested, and bad attacks occur on clays, sands, and limestone soils.

NATURAL ENEMIES.

On the whole, the natural enemies of slugs and snails are few and insufficient to keep their numbers in check, but rooks, starlings, blackbirds, thrushes, and ducks eat slugs as part of their food, and thrushes eat snails Slugs are also devoured by toads, moles, and shrews; some are killed by predacious ground beetles.

METHODS OF CONTROL.

Slugs and snails are notoriously difficult to control and complete eradication is hardly to be expected. Nevertheless, the damage caused by them can be much reduced by persistent use of one or other of the measures mentioned below.

Traps and Hand Collection.—In gardens, large numbers of slugs may be caught by means of traps consisting of cut potatoes, orange skins or cabbage leaves, from which the animals may be collected at intervals and destroyed.

Boards, tiles, or sacking placed on the soil also serve the same purpose, for slugs will collect under them to shelter during the day. General collecting by hand at dusk may also be helpful, especially where snails are troublesome.

Poison Baits.—A bait that has given very good results under most conditions is made by mixing with bran a small quantity of the compound Metaldehyde which is obtainable as a solid fuel (formerly known as "Meta") for heating small domestic appliances. It is usually sold in packets containing small sticks or bars and the bait is made up in the porportions of 1 oz. of Metaldehyde to 3 lb of bran, or, for large areas, ½ lb to 25 lb of bran.

The Metaldehyde is finely powdered and mixed thoroughly with the bran, and the mixture may then be used dry or slightly damped with water but not wetted sufficiently to make the flakes stick together.

It is important that the Metaldehyde should be finely ground and free from lumps and that it should be very thoroughly and evenly mixed with the bran.*

A mild evening, when the soil is moist, should be chosen for distributing the bait; dry or frosty conditions are unsuitable. The bait may be applied either by broadcasting very thinly† over the whole area to be treated or by placing it in quite small heaps, about 1 ft. apart, under tiles or similar covering to protect it from rain and birds.

Broadcasting is the only satisfactory method of treating large areas, but heavy rain reduces the efficiency of the bait. Small heaps under cover will remain effective for some weeks.

The bait is strongly attractive to slugs and snails; the Metaldehyde has a rapid initial action, making them almost incapable of movement and they are found in a moribund condition on the surface of the soil. Unfortunately, the bait does not appear to attract other soil pests, and there is no evidence that it is effective against leather jackets, millepedes of woodlice.

Methaldhyde is dangerous to the health of human beings if eaten. It is essential, therefore, to take all precautions in preparing the bait and using it; in particular, the sticks or bars of Metaldehyde which somewhat resemble sweets, should be kept out of the reach of children. Further, in order to avoid any chance that domestic animals or birds might eat sufficient to cause harm, the bait should not be left uncovered in any quantity in accessible possitions. If the Metaldehyde is finely powered and the bait properly prepared and distributed, there is little or no risk of injury.

In certain circumstances, attacks by slugs may be greatly reduced by a bait consisting of moist bran and Paris Green‡, as used for the control of leatherjackets.

Copper Sulphate.—Certain materials are destructive to slugs if applied at night when

they are on the surface, and of many substances tried, copper sulphate has proved the most toxic, a single application either powdered or in solution being rapidly fatal. It is, however, also highly injurious to green plants and care is therefore needed when using it.

The best method appears to be to mix the copper sulphate with kainit (6 lb copper sulphate per 1 cwt. kainit) and distribute this mixture at night at the rate of 3 cwt. per acre. Such treatment has given good results in many instances without causing injury to growing crops such as young oats, peas, and sugar-beet.

Protective Dressings.—A number of substances have been found that are repellent to slugs, and some are useful as protective dressings in market gardens, allotments, and private gardens. It is well known that slugs will not readily pass over barriers of lime or soot. Washing soda, crude naphthalene, aluminium sulphate, copper sulphate, and dry Bordeaux Mixture powder (sold as " dry Bordeaux ") are also repellent. Barriers of such materials may be placed along rows of seedlings or used to protect individual plants, but all lose their efficacy when moist and need to be frequently renewed in wet weather.

—Advisory Leaflet Ministry of Agriculture and Fisheries Berri Court Hotel, St. Annes, Lytham St. Annes, Lancs.

1 *Helix asporsa* Mull.
2 *Hygromia striolata* Pfeiff.
3 *Helix. nemoralis* L. and *H. hortensis* Mull.
4 *Agriollmax reticulatus* Mull.
5 *Arion hortensis* Fer.
6 *Arion cirumscriptus* Johnst.
7 *Milax gracills* Leyd., *M. sowerbli* Fer. and *M. gagates* Drap
8 *Arion ater* L.

* For treatment of small areas, other feeding stuffs or even waste materials such as tea leaves or sawdust may be used if bran cannot be obtained.

† 2-3 oz. of the mixture per rod (25 lb per acre) are sufficient.

‡ Paris Green is exceedingly poisonous and must be used with great care.

FIJI COPRA PRODUCTION BY AREAS.

The following table which shows the contribution by different areas of the Colony to the total production of copra has been compiled from the grading returns on copra submitted for grading at Suva and Levuka with the addition of those amounts shipped overseas from Savusavu and Rotuma. The analysis is not entirely accurate as no check can be made on small quantities of copra moved from one district to another but it is sufficiently accurate to indicate the relative importance of each producing area.

Comparison of 1948 figures with those of 1942 shows to what extent each of the areas has contributed to the recovery in total production since the period of low prices and shortage of labour of the early war years.

	Copra in tons.		Percentage of total production.	
	1942	1948	1942	1948
Lau	2,778	6,285	16	18
Lomaiviti	694	3,530	4	10
Taveuni	4,167	7,600	24	22
Vanua Levu	6,424	14,065	37	41
Viti Levu inc.	..	..	..	..
Kadavu & Yasawas ..	1,215	940	7	3
Rotuma	2,083	2,218	12	6
Total	17,361	34,638	100	100

—C.H.

CONTROL OF JOHNSON GRASS

During recent years a very encouraging degree of success has been achieved in the destruction of Johnson grass by means of weedkillers. Treatment is rather expensive and in some cases does not give a complete kill. Factors such as stage of growth, season, amount of moisture in the soil and even the time of day at which spraying is carried out, all appear to influence the results of spraying weeds with underground stems. Consequently, a considerable amount of investigational work is necessary before the best set of conditions for spraying can be determined.

Until definite recommendations can be made, the following procedure is suggested. It is a somewhat tighter procedure than that adopted by some farmers, who are apparently getting satisfactory results with a wide range of treatment, but new users can deviate from the procedure outlined if they desire to experiment.

WEEDKILLER TO USE.

The weedkillers which have proved satisfactory against Johnson grass have sodium chlorate or a mixture of sodium chlorate and calcium chlorate as their poisonous base. For a heavy infestation carrying a bulky top growth the amount of chlorate necessary per acre is about 400 lb Straight sodium chlorate may be made up at 1 lb per gallon of water and the solution applied at 400 gallons to the acre. An equivalent amount of chlorate would be contained in about 160 gallons of "Atlacide" solution diluted with 240 gallons of water. These are 10 per cent strengths—that is, 1 lb of chlorate in one gallon of spray solution. In some cases probably a 7½ per cent strength—that is, ¾ lb of chlorate in one gallon of spray solution—would suffice, but farmers starting off on spraying are advised to use the stronger solution.

Chlorate for weedkilling purposes costs roughly one shilling per pound, so the cost of material for a dense acre would be about £20, with additional expense for follow-up applications on a smaller scale.

The efficiency of the weedkiller may be increased by adding a wetting and spreading agent—such as Agral 2 at the rate of 1 lb to 100 gallons of spray solution.

STAGE OF GROWTH.

Though some farmers claim to have had good results from spraying young growth of Johnson grass, experimental work suggests that the flowering stage is the best stage in which to attack the weed. It is generally accepted that a fairly large amount of chlorate must be carried down into the underground stems in order to ensure their death. A large top growth, such as is present in the early flowering stage, would be more likely to absorb the requisite amount of chlorate than a less prolific growth. It is quite likely, however, that if a heavy application of spray is made, the fairly large proportion which runs to the ground would in due course be absorbed by the underground runners and assist in their destruction.

SOIL CONDITIONS.

Little information is available as to the best soil conditions for the action of chlorates on plants with rootstocks. As already pointed out, in order to kill the vigorous underground creeping stems, movement of the chlorate in the sap from the leaves downwards, is necessary. Theoretically, this movement is greater when soil moisture is low than when the soil is wet. Consequently, spraying may possibly be most effective if carried out in early autumn when the soil is drying out after summer rains, or in a dry period following early spring rains.

TIME OF DAY TO SPRAY.

Here again there is little information available for Johnson grass. Downward movement of chlorate absorbed by leaves is usually more rapid if plants are sprayed after sundown, but in Queensland satisfactory kills have been obtained by ordinary day time spraying.

EQUIPMENT.

The chlorates are non-corrosive and can be used in any spraying equipment. Knapsack spraying appears to be less effective than using a power spray outfit of the orchard type. The latter is, of course, much faster and spray booms up to 40 ft. in width can be used.

PRECAUTIONS.

Though chlorates are much less dangerous to use than are arsenicals, they present some special hazards. In the first place, plants sprayed with chlorates are rendered specially attractive to stock, and though the amount of chlorate eaten may not be sufficient to kill the animals, possibly the prussic acid normally present in Johnson grass would lead to death.

Sodium chlorate when it dries out on inflammable material, such as clothing, is very easily ignited. Clothes and boots should therefore be thoroughly washed after being wetted with chlorate solution. "Atlacide" is comparatively safe to use because it contains chemicals which absorb moisture from the air and prevent the chlorate from drying out on the clothes.

—Queensland Agricultural Journal.

PEASANT AGRICULTURE IN TRINIDAD[1]

Attention is once again being focused on land settlement schemes in the British West Indies and elsewhere as a means of improving the efficiency of the peasants and increasing their numbers. The mere settlement of labourers on the land, however, does not in itself make efficient peasants, and many technical questions as to how a settlement should be organized and what are sound systems of peasant farming are at present in doubt. The only way to answer these questions is to establish investigational units of various sized holdings managed under different systems of agriculture. The Imperial College of Tropical Agriculture is pioneering this work and established the first peasant investigational unit on its farm at St. Augustine, in May, 1946. The investigations which are being made on this unit under the management of a committee of six, consisting of the Professor of Agriculture, as chairman, the Director of Agriculture, Trinidad, the Professor of Economics, the Professor of Chemistry and Soil Science, the Lecturer in Economics, as members; and the Senior Lecturer in Agriculture as secretary. This committee meets monthly in order to examine and discuss the data collected from the peasant investigational unit. Also, to stimulate as wide an interest as possible in the investigations, the minutes of the committee's meetings are forwarded to the Directors of Agriculture in the British West Indies, and other interested officials.

The peasant investigational unit, started in May last year, covers three acres of arable land on which a rotation similar to that practised on the college farm is followed with sugar cane and yams as the major cash crops. One milking cow with calf are kept by the peasant. No working oxen are included, as it was decided that this first unit should be typical of as many peasant areas as possible. In most peasant areas working oxen are not kept for various reasons, such as conformation of the land, nature of the soil, etc. As it was thought desirable to work on the principle of mixed farming, the cow was included as a source of organic manure and of immediate revenue for the sale of milk. Detailed records are kept of all hours of work on each crop and on the livestock, of all sales and of all expenses incurred by the peasant and his family on food, clothing, medicines, etc. Thus the first peasant family was carefully chosen and numbers four in all; a man and his wife, and two young girl children. The committee has planned a series of peasant holdings of various sizes ranging from a one acre pure market garden up to a 15 to 20 acre holding. All the systems of agriculture to be adopted on these holdings are based on the mixed farming principle. The whole investigation is being run as follows: first there is the preliminary stage, i.e. experiments with crops and stock, rations, varieties of crops, systems of management, etc. This work will be carried out on the college farm. The next stage is the experimental one and here the experimental peasant units will be laid down, each worked by a peasant and his family under direction—with the.e the detailed records will be kept. When it has been decided that an economic type peasant holding has been run successfully, then this holding will be duplicated in a demonstration holding, also under direction. All data from the demonstration holdings will be published and visitors encouraged to inspect them. No new or speculative systems will be tried on these demonstration holdings; only those proved and passed

in the experimental holding will be incorporated in the demonstration holding. Demonstration holdings will be situated in a separate area, and not mixed up with experiment or experimental areas.

Owing to lack of funds it had only been possible to establish one experimental unit. Recently, however, thanks to the good offices of the Comptroller for Development and Welfare, and his Agricultural Adviser, funds have been made available for three additional experimental holdings on which work will commence immediately. These will be sited on the College Farm, I.C.T.A., and will consist of the following: 1. A duplicate of the first experimental holding with the addition of one pair of ploughing oxen. This will give a comparison between a holding worked entirely manually and one where the heavy work can be done with the assistance of animal-drawn implements. It is possible that three acres will be too small for this type and the holding will be sited with due regard for possible expansion. 2. A three acre holding, having less arable land, more breeding stock and more emphasis on vegetable production. This holding will carry two milking cows, one in-calf heifer and two breeding sows. Thus, for this holding there will be an increased production of organic manure and more revenue from milk sales. 3. A one acre market garden with one cow and two breeding sows. This holding will produce vegetables only. All " peasants " on these investigational units will be paid a daily wage and work under the direction of the College Department of Agriculture as in the case of the first unit laid down. All holdings will grow fodder for their livestock and this will be established for them, as it is considered necessary to have fodder ready for immediate use. The cutting of roadside grass, etc., is very time-consuming, and this time can be more profitably used on the holding. The cost of establishing fodder grass areas will, of course, be assessed. All holdings will be residential, and laid out in such a way as to produce the maximum of comfort combined with economic running.

(1) Reprinted from the West India Committee Circular, April, 1947.

REVIEW

PROFESSOR PEREN'S PEREGRINATIONS.*

Pofessor Peren, Principal of Massey Agricultural College, New Zealand, has published a report on a visit to points of agricultural interest in Samoa, the Cook Islands and Fiji. The visit, extending over a month, was undertaken largely to secure liaison with agricultural authorities and a general appreciation of the agriculture of the islands, from which students from time to time come to the College for training, thus stimulating the College's interest and desire to help island agriculture.

Professor Peren discusses crops, livestock and conditions in the different groups and emphasizes the difficulties of liaison among the islands, due in his opinion largely to their diverse sovereignties. He suggests the desirability of a closer unification of activities of New Zealand, Australia and the islands including the formation of a team of technical officers possibly with headquarters in Suva, who for the sake of economy in scientists no less than in finance would be available as need arose for short-term service in the different island territories of the South Pacific. Their duties would be to develop and co-ordinate the growing of further suitable crops, to improve storage facilities " and to encourage the islanders away from their laissez-faire attitude towards sustained work ".

Professor Peren comments on the fact that the islanders are very largely at the mercy of chance in the matter of markets and contrasts their position with that of highly organized mass-production areas such as tropical Africa. A possible solution, he suggests, at least in the case of those islands under New Zealand jurisdiction, would be to extend the principle of the guaranteed price to produce marketed in N.Z. " So far as the Islands as a whole are concerned, however, it seems to me essential that, as a prelude to any agricultural development, some suitable form of economic team-work must be thrashed out ".

* "Report on the Agriculture of Samoa, Cook Islands and Fiji," by Prof. S. G. Peren.

Aerial view of site for Principal Agricultural Station, Fiji. 11 miles from Suva. King's Road passes through the station area. Toga branch of Rewa River at top of picture.

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